DOCUMENT RESUME

ED 133 462 CE 008 837

AUTHOR	Oriel, Arthur E.
TITLE	Joint Workshops. Performance Based Apprentice and Technical Training. Final Report.
INSTITUTION	Oriel (A. E.) and Associates, Ltd., Chicago, Ill.
SPONS AGENCY	Employment and Training Administration (DOL), Washington, D.C.
PUB DATE	Sep 76
GRANT	DL-21-17-75-09
NOTE	127p.; Several pages may not reproduce well due to marginal legibility of the original document
AVAILABLE FROM	National Technical Information Service, Springfield, Virginia 22151
EDRS PRICE	MF-$0.83 HC-$7.35 Plus Postage.
DESCRIPTORS	*Apprenticeships; Audiovisual Communication; Business; Educational Research; Higher Education; *Industrial Training; Industry; *Performance Based Education; Post Secondary Education; *Technical Education; Vocational Education; Workshops

ABSTRACT

A series of five workshops were held to disseminate, to 39 industrial and college and 61 Bureau of Apprenticeship and Training (BAT) personnel, information about the principles, methods, and effectiveness of Performance Based Training (PBT) in apprentice programs. Following the workshops, 90% of the industrial and 61% of the BAT personnel indicated they would recommend the use of PBT for industrial training. Sixty-four percent of the industrial and college participants have started or plan to use PBT in their training programs. Nearly 75% of these are well satisfied with the results produced by PBT. Some of the major results reported include 10% reduction in equipment downtime, more productive apprentices earlier in their training, faster training at reduced cost, better safety performance, and better work quality. The data offers evidence that such workshops are an effective means of communicating research results and new methods to industry and schools. The majority of this report is composed of the following appended material: Workshop program; list of participants; workshop questionnaire; workshop questionnaire responses--industry; workshop questionnaire responses--Department of Labor participants; followup questionnaire; followup responses; report of a study on performance based education in technical and apprentice training; and a 28-page annotated bibliography on performance based training. (HD)

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FINAL REPORT

JOINT WORKSHOPS FOR PERFORMANCE BASED APPRENTICE AND TECHNICAL TRAINING

ARTHUR E. ORIEL

Submitted to:
Office of Research and Development
Employment and Training Administration
U.S. Department of Labor

BEST COPY AVAILABLE

The material in this project was prepared under Grant No. 21-17-75-09 from the Employment and Training Administration, U.S. Department of Labor, under the authority of Title III, Part B of the Comprehensive Employment and Training Act of 1973. Researchers undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment. Therefore, points of view or opinions stated in this document do not necessarily represent the official position of the Department of Labor.

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Chicago, Illinois 60614

Sept. 1976

UC 018 837

BIBLIOGRAPHIC DATA SHEET	1. Report No. DLMA 21-17-75-[illegible]-2	2.	3. Recipient's Accession No.
4. Title and Subtitle: Joint Workshops: Performance Based Apprentice and Technical Training			5. Report Date: Sept. 1976 6.
7. Author(s): Arthur E. Oriel			8. Performing Organization Rept. No.
9. Performing Organization Name and Address: A.E. Oriel and Associates, Ltd. 2242 North Fremont Chicago, Illinois 60614			10. Project/Task/Work Unit No. 11. Contract/Grant No.: DL 21-17-75-09
12. Sponsoring Organization Name and Address: U.S. Department of Labor Manpower Administration Office of Research and Development 601 D Street, N.W., Washington, D.C. 20213			13. Type of Report & Period Covered: Final 9/74 to 9/76 14.

15. Supplementary Notes: Workshops co-sponsor: National Machine Tool Builders Association

16. Abstracts: A series of five workshops was held to disseminate, using films, 35mm slides and printed materials, to 39 industrial and college and 61 BAT personnel, information about the principles, methods and effectiveness of Performance Based Training in apprentice programs. Following the workshops 90% of the industrial and 61% of the BAT personnel indicated they would recommend the use of PBT for industrial training. Sixty-four percent of the industrial and college participants have started or plan to use PBT in their training programs. Nearly 75% of these are well satisfied with the results produced by PBT. Results reported include: 10% reduction in equipment downtime, more productive apprentices earlier in their training, reduced scrap, better safety performance, better work quality, faster training at reduced cost. The data offer ample evidence that such workshops are an effective means of communicating research results and new methods to industry and schools.

17. Key Words and Document Analysis. 17a. Descriptors

Apprenticeship
Attitudes
Craftsmen
Education
Effectiveness
Employment
Evaluation
Industrial Training
Instructors
Job Analysis
Job description
Learning
Manpower Utilization
Performance
Performance evaluation
Personnel
Personnel development
Personnel selection
Placement
Program Instruction
Skilled workers
Specialized training
Supervisors
Technical Schools
Technicians
Trainingdevices
Upgrading
Vocational guidance
Work sampling

17b. Identifiers - Open-Ended Terms

Task analysis
Performance analysis
Cost-effectiveness
Metal trades

17c. COSATI Field/Group: 5I 5J 14A

18. Availability Statement: Distribution is unlimited. Available from National Technical Information Service, Springfield, Va. 22151.	19. Security Class (This Report): UNCLASSIFIED	21. No. of Pages: 125
	20. Security Class (This Page): UNCLASSIFIED	22. Price

FORM NTIS-35 (REV. 3-72) THIS FORM MAY BE REPRODUCED USCOMM-DC 14952-P72

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ACKNOWLEDGMENTS

The Performance Based Training Workshops described here could not have been held without the dedicated and generous help of a large number of people.

John Mandl, of the National Machine Tool Builders Association, which co-sponsored the workshops, supplied valuable counsel on the workshop format and content, served admirably as chairman of the sessions and provided welcome assistance on workshop arrangements and industrial personnel to be invited.

Very special thanks go to Nicholas Anton and Caterpillar Tractor Company. Mr. Anton made substantial contributions to the success of the workshops through his thoughtful and competent participation as a developer, speaker and workshop leader. Without the plant facilities and staff made available to us by the company, the motion picture used in the workshops could not have been produced.

We would like to thank Mr. Hugh C. Murphy of the Bureau of Apprenticeship and Training for arranging for regional BAT personnel to attend workshops in Chicago and Boston.

Special thanks go to Dr. Howard Rosen and A. Lafayette Grisby, Office of Research and Development, Employment and Training Administration, U.S. Department of Labor for their encouragement and support in the development and conduct of the workshops.

Finally, our special gratitude goes to all the participants in the workshops, those from industry, colleges and the BAT whose responsiveness, questions and lively discussion made the workshops such an enjoyable experience.

SUMMARY

During April, 1975 a series of five workshops was conducted, two (in Chicago and Boston) for industrial training and technical college personnel, two for regional personnel of the Bureau of Apprenticeship and Training (BAT) and one for officials of the U.S. Department of Labor in Washington, D.C.

The purpose of the workshops was to disseminate to industry and BAT personnel information about the principles, methods and effectiveness of Performance Based Training (PBT) in apprentice training programs.

The workshops were co-sponsored by the National Machine Tool Builders Association and were conducted by the author, Nicholas Anton, Training Manager of the Joliet, Illinois plants of

Caterpillar Tractor Company and John Mandl, Training Director of NMTBA.

A 15 minute color motion picture and approximately 250 (35mm) slides were developed, together with a variety of printed material for use by participants in the workshops. These materials covered in detail the basic principles and procedures of Performance Based Training, documented evidence of its effectiveness in industrial technical and apprentice training, and a summary of the pertinent PBT literature.

Thirty-nine industrial training and technical college personnel attended the workshops as did 61 people from state labor departments, the U.S. Department of Labor and the Bureau of Apprenticeship and Training regional offices. Twenty-seven different companies and four colleges were represented.

Participants reactions to the workshops were generally positive. The industrial personnel were most favorable and enthusiastic about both the workshops and PBT and its potential use in apprentice and technical training.

More than 90% of the industrial participants and 61% of the BAT personnel indicated, at the end of the workshops, that they could and would recommend the use of PBT for industrial training.

More important, 64% of the industrial and college participants are now using (subsequent to the workshops) or are planning to use, or expand their use of PBT methods in their apprentice and technical programs. This is more than double the number that were using these methods prior to attending the workshops. The applications being made involve virtually all of the skilled trades and a wide variety of semi-skilled jobs.

The major obstacles to the use of PBT are seen as the cost of developing training materials and the resistance to change that may be anticipated, or has already been encountered, from management and unions.

Nearly three quarters of the companies and schools that have applied PBT are well satisfied with the results they have obtained.

Results include:

(1) A 10% reduction in equipment downtime.
(2) More productive apprentices earlier in their apprenticeships.
(3) Reduced scrap.
(4) Better safety performance.
(5) Better quality of work.
(6) Trainees move through training faster.
(7) Lower instructional costs per trainee.

About half the companies that are applying PBT feel they need additional help in task analysis, defining objectives and performance measurement, developing training materials and having continuing access to information on PBT. Most feel this help should come from their own organizations, trade associations or state and federal governments.

Most of those organizations that have not yet applied PBT (Only 16% indicated they did not intend to apply PBT methods.) either have had training activities curtailed by the recession or they are in the process of trying to get approval of budget and staff to start implementing PBT methods.

There is ample evidence that such workshops are effective in communicating and explaining innovations in training methodology.

There is also considerable evidence, which supports the author's conclusions in his initial study on the use of PBT in apprentice training, that such modern performance oriented training methods can have a vital and positive impact on training time, quality and cost.

U.S. industry appears to be moving, at an accelerating pace, toward the adoption of PBT methodology in apprentice training. It is recommended that the U.S. Department of Labor assume a leadership role in this movement and provide the aid companies need in converting to a system of demonstrated performance rather than accumulated time. Performance rather than time is, of course, what interests industry as labor and training costs spiral. If the Department of Labor does not now assume a leadership role, it will, we believe, eventually find itself in the role of follower.

DEVELOPMENT OF THE WORKSHOPS

Objectives

The five Performance Based Training workshops described in this report were conducted for the purpose of communicating to specific groups, not for research purposes. Their objectives were as follows:

1. To disseminate information about the basic methods and principles outlined in the study "Improving Performance in Technical and Apprentice Training", recently completed by the author of this report.

2. Explain more fully to technical college and industrial training personnel and U.S. Department of Labor personnel the methods and materials of Performance Based Training

and their impact on both the quality and the cost of apprentice and technical training in both schools and industry.

3. Offer technical guidance for schools or industrial organizations that may want to develop and/or implement PBT systems.

4. Provide detailed information in the wider field of individualized training as it applies to technical and skills development, and on how currently available methods and materials may be used in existing apprentice and technical training programs.

Rationale

The major assumption underlying the workshops -- indeed the primary reason for their development -- was that many of the people responsible for apprentice training in industry and in the U.S. Department of Labor had little knowledge of the new Performance Based Training methods and modern training and educational technology.

Based on that assumption it was decided that the workshops should be co-sponsored and co-developed by a company or organization that was involved in apprentice training and whose philosophy was consistent with the modern performance oriented approaches to personnel training. It was further decided that the workshops should include the following:

1. The basic principles and philosophy of Performance Based Training (PBT).

2. A comparison of the characteristics of PBT with those of conventional training programs.

3. The specific procedures involved in the development of PBT: performance analysis, task analysis, design of instructional materials, testing and validation of PBT materials, measurement of training results, cost-benefit analysis, how to convert a conventional training operation to PBT and a concrete example of the impact of PBT on performance and training costs.

4. The results of the research done by the author on the effectiveness of PBT both in reducing training and instructor time and costs and in improving the performance of trainees.*

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*Oriel, A.E., Improving Performance in Technical and Apprentice Training, 1974, National Technical Information Service, Springfield, Virginia 22151.

5. A summary of the research and implementation literature in the broad field of individualized training methodology and information on individualized instructional materials currently available on the market for use by industry and schools.

Workshop Program and Materials

Consistent with the objectives and rationale outlined above, Nicholas Anton, Training Manager of the Joliet plant of Caterpillar Tractor Company, was asked to join the author as co-leader of the workshops. He was a particularly appropriate choice since the Joliet plant had participated in the author's government supported research on the application of PBT to apprentice training. Subsequent to that research Mr. Anton converted virtually his entire training operation to performance based systems. Thus, he was in an excellent position to provide workshop participants with first-hand advice on how to apply PBT in their training activities, and on the costs involved.

To ensure further that the workshops would be of maximum value to industrial apprentice training personnel, the National Machine Tool Builders Association agreed to co-sponsor the workshops. John Mandl, Training Director of NMTBA agreed to participate as chairman of each workshop and to introduce the workshop speakers.

Between September and November 1974, John Mandl, Nick Anton and the author worked out and agreed upon a workshop program that would provide participants with: a reasonably detailed description of the basic principles and methods of PBT; research and practical evidence of its effectiveness in industrial training (with emphasis on apprentice training); an overview of the PBT literature and training materials available for use.

A copy of the complete workshop program can be found in Appendix A on page 22.

Film -- To implement the workshop program a variety of materials were developed. A fifteen minute, 16mm color motion picture was produced which described in graphic detail the basic characteristics and principles of PBT, the research on PBT conducted by the author and the results of that research obtained in field tests of the PBT system in Caterpillar Tractor Company, International Harvester and other locations. The film also described in detail how the Joliet plant of Caterpillar Tractor Company has converted most of its training effort to PBT and the impact of the new training systems on training time and cost.

Slides -- Approximately 250 color slides (35mm) were produced for use in the workshops to illustrate and elucidate such PBT principles as task analysis, performance analysis, cost-benefit analysis and a variety of other workshop topics.

Research Report -- A 16 page summary of the author's 1974 study on PBT was written and printed for distribution to participants.*

Task Analysis -- Since task analysis forms the foundation of all effective performance based training systems, a 21 page paper by the author on the uses and procedures of task analysis was distributed to participants.

Bibliography -- To help acquaint participants with the literature in the broad PBT field, approximately 1800 publications were reviewed. An annotated bibliography was assembled which described and reviewed 89 relevant publications covering the following subjects:

Apprentice and Technical Training
Performance Analysis
Task Analysis
Behavioral Objectives
Effectiveness of PBT
PBT Program Development
Cost-Effectiveness of PBT
Performance Testing

Handout Material -- In addition, case problems on performance analysis, training system design and cost-benefit analysis were developed. Algorithm flow charts depicting the steps in performance analysis, task analysis and instructional materials development were distributed together with a reprint of a published article on the use of PBT by Lockheed of Georgia to train machine tool operators.

CONDUCT OF THE WORKSHOPS

March 4, 1975	Chicago	BAT*
March 24, 1975	Wash., D.C.	U.S. Dept. of Labor Personnel
April 3, 1975**	Chicago	Industrial Personnel
April 16, 1975	Boston	BAT*
April 17, 1975	Boston	Industrial Personnel

*Bureau of Apprenticeship and Training regional personnel.

**This workshop was rescheduled on April 30, 1975 because a heavy snow storm in Chicago on April 2, 1975 made it impossible for participants to get into the city.

A total of 100 people attended the five workshops. The breakdown by location and type of affiliation is set forth in the chart

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*Ibid.

below.

	Chicago	Boston	Washington	Total
BAT	17	8	--	25
State Labor Dept.	--	18	--	18
U.S. Dept. of Labor	--	--	18	18
Industrial	16	17	--	33
Technical College	6	--	--	6
TOTALS	39	43	18	100

Twenty-seven different companies and four colleges were represented at the workshops. The following industries were represented:

Electric Utilities	3
Pharmaceuticals & Chemicals	4
Ship Building	1
Manufacturing	9
Transportation	2
Publishing	2
Automotive & Farm Equipment	3
Miscellaneous	3
	27

A complete list of participants in the Boston and Chicago workshops is in Appendix B on page 24.

Of the 39 companies and technical colleges represented, none, prior to the workshops was using a complete PBT system to train skilled trades apprentices. Thirty percent of the participating organizations, however, were using some type of individualized training materials. There was, thus, at least minimal knowledge and utilization of PBT methods among the participants.

Twenty-two of these organizations indicated that they expected to train 1136 apprentices (across a wide variety of skilled trades) during the next 12 to 18 months.

It was not possible, however, to gather from these organizations reliable data on the cost of training skilled trades apprentices. Only 14 organizations provided any cost figures and only one of these included both apprentice and journeyman wages as part of the total cost of training.

The reported yearly cost of training apprentices ranged from a low of $334 to a high of $5000. The average of 14 companies was $1643 per year. Fifty-five percent of the companies and schools either failed to provide training cost data or said it was not available. As has been true of other surveys of industrial training costs, many companies either are reluctant to make these figures public, or they are doing a haphazard and incomplete job

of accounting for the full costs of training.

Reactions to the Workshops

At the end of each workshop participants were asked to complete a questionnaire dealing with their attitudes toward the workshop and PBT as an apprentice training technique. A copy of that questionnaire is in Appendix C.

The attitudes of participants, as expressed in that questionnaire are summarized below. Each question is underlined below and is followed by a quantitative summary of responses. Complete responses of participants to each question are reproduced in Appendices D and E.

1. Now that you have attended the full workshops, we'd appreciate it if you would give us your concrete suggestions on how we might make the workshop more effective. Please write specific suggestions for each part of the workshop listed below. Consider content, speakers' delivery, audio/visual aids, and whatever else you may consider relevant.

1.1 OVERVIEW OF WORKSHOP and PERFORMANCE BASED TRAINING (PBT)

	Industrial	U.S. Dept. of Labor
Excellent	35%	19%
Very Good	26	14
Good	15	14
OK	3	7
No Answer or Unclassifiable	15	5
Other - positive response	3	31
Other Suggestions	3	10

1.2 PERFORMANCE ANALYSIS

Excellent	18%	16%
Very Good	12	5
Good	18	19
OK	3	5
No Answer or Unclassifiable	40	23
Other - positive response	--	25
Other Suggestions	9	7

1.3 TASK ANALYSIS

	Industrial	U.S. Dept. of Labor
Excellent	24%	12%
Very Good	6	5
Good	21	19
OK	6	7
No Answer or Unclassifiable	35	24
Other - positive response	--	24
Other Suggestions	9	10

1.4 MOTION PICTURE

Excellent	12%	5%
Very Good	21	5
Good	29	35
OK	6	7
Fair or Poor	3	3
No Answer or Unclassifiable	20	20
Other - positive response	9	14

1.5 PERFORMANCE BASED TRAINING at CATERPILLAR

Excellent	9%	7%
Very Good	9	12
Good	24	25
OK	6	9
No Answer or Unclassifiable	34	26
Other - positive response	18	21

1.6 SELECTING, DESIGNING and VALIDATING PERFORMANCE BASED PROGRAMS

Excellent	12%	2%
Very Good	9	7
Good	12	14
OK	3	9
No Answer or Unclassifiable	38	35
Other - positive response	3	14
Other Suggestions or Poor	23	18

1.7 CASE PROBLEM ANALYSIS

Excellent	6%	7%
Very Good	8	7
Good	26	21
OK	6	7
Fair or Poor	3	2
No Answer or Unclassifiable	36	49
Other - positive response	3	5
Other Suggestions	12	2

2. Now let's consider PBT as described in this workshop, and the varied forms of it that are in use in Caterpillar Tractor Co., Ford Motor Co., Lockheed-Georgia, DuPont and other companies and schools.

Listed below are some of the major characteristics of PBT. Please check the three (3) characteristics which, in your opinion, are most important in making the decision to implement PBT in industry or in schools. (CHECK 3)

	Industrial	U.S. Dept. of Labor
It tends to standardize training. All trainees get the same instructions.	29%	36%
It is based on specific, detailed task specifications.	32	58
It capitalizes on individual differences in learning ability, thereby increasing its efficiency.	62	55
It attempts to hold performance constant while letting learning time vary.	44	31
It reduces learning time required.	32	33
It reduces instructor time required.	0	21
It has measurement of results built into the system.	41	36
Movement through the program is based on task achievement rather than time.	50	43
Other (Please specify.)		
Definitely a need for this in apprentice training.	0	2
It is cost effective.	3	2
It is more flexible.	3	0
No Answer	3	3

3. Having completed the workshop, do you feel you can now recommend to your own or to other companies that they use the methods of Performance Based Training? (We are referring here to the methods, not to any specific materials.) Please reply in your own words.

	Industrial	U.S. Dept. of Labor
Yes	68%	49%
Qualified Yes	23	12
Need more investigation	3	--
No	--	5
Qualified No	--	7
No Answer	6	28

Responses to the questions above indicate clearly that the industrial participants expressed more positive attitudes toward the workshops than did the personnel from the Bureau of Apprenticeship and Training. The attitudes of the former were almost universally positive. They expressed virtually no negative attitudes. As anticipated, the BAT personnel tended to be somewhat less enthusiastic. A small percentage were somewhat critical; one or two felt that more jokes and humor would have improved the workshops.

There were only minor differences between the BAT and industrial participants with respect to which of the characteristics of PBT were most important in deciding to implement it in industry or schools. More so than industrial people, the BAT personnel tended to favor standardization of training, while the industrial personnel felt that holding performance constant was more important.

More than 90% of the industrial personnel said that, having completed the workshop, they would or could now recommend that PBT methods be used in industrial training. Only 61% of the BAT personnel responded this way and 12% gave a negative answer.

4. Please describe briefly what you consider to be the major obstacles to the use of PBT in industry or schools.

	Industrial	U.S. Dept. of Labor
Tradition of time based training in industry and education	29%*	18%
Union resistance	9	0
Lack of management acceptance	21	2

	Industrial	U.S. Dept. of Labor
Availability of good materials, equipment and personnel	9%	5%
Political and economic	6	5
Lack of knowledge of PBT	6	0
Budgetary considerations	21	19
Instructor insecurity	9	5
Government regulations	3	0
Lack of performance standards	3	0
No answer	9	30
Too complex for small companies	--	7
No obstacles	--	7
Dehumanizing	--	2

*Figures add to more than 100% because a number of participants gave more than one response.

5. Please describe briefly what you consider to be the major shortcomings of PBT as it is now being used in industry and schools.

Lack of knowledge of PBT	15%	9%
No uniform performance standards	9	0
Lack of acceptance by unions, instructors and management	15	7
Not flexible enough	6	0
Depends on student motivation	6	4
Cost	6	0
Too specific	3	2
Still linked to time	3	0
Problems are with schools and industry, not with PBT	6	4

	Industrial	U.S. Dept. of Labor
No answer	31%	49%
Dehumanizing	--	2
None or unknown or don't know	--	23

6. Please use this space for any other comments you may have.*

*Actual comments taken from questionnaires appear in Appendices D and E.

The major shortcomings of PBT were expressed by both groups as a lack of knowledge of PBT in industry, lack of acceptance of it by unions, management and instructors and a current lack of uniform performance standards.

The group also agreed reasonably well that the major obstacles to the wider use of PBT in industry and schools are the long tradition of time-based training in industry and education, lack of management acceptance and the cost of developing PBT systems.

The workshops may have failed to emphasize strongly enough that in the process of developing a PBT system, uniform performance standards are established as an integral part of the system. Thus, the lack of such standards cannot be a shortcoming of PBT.

The other obstacles and shortcomings, lack of acceptance and knowledge of PBT are exactly the reasons the workshops were developed. These can be overcome only by a continuing education and demonstration program.

IMPACT OF THE WORKSHOPS ON INDUSTRY

In February 1976, ten months after the workshops had been held, a follow-up questionnaire was sent to each of the participants from industry or a college. The purpose of the questionnaire was to determine to what extent workshop participants were applying the principles and methods of PBT that had been covered in the workshops. A copy of the follow-up questionnaire is in Appendix F.

Questionnaires were sent to industrial personnel representing 29 different companies or different divisions of the same company, and to participants from four technical colleges.

A total of 23 responses were received from industry, a 79% response although one of those responses was in the form of a

letter rather than a completed questionnaire. The letter writer's attitude toward PBT was enthusiastic, but he explained that, due to the recession, his company had been laying off people and, thus had no one to train. Responses were received from three of the four technical colleges (75% response).

Responses to the follow-up questionnaire received from the three technical colleges were almost identical to those received from industry. For that reason, responses from the two groups are lumped together and will be reported as a single group.

Responses to the questionnaire which may be quantified are presented below. Each question is underlined followed by a summary of responses to that question. Responses to questions which asked for open-ended or "in-your-own-words" replies can be found in Appendix G.

1. <u>During the past year have you or your organization applied any of the principles and/or methods of PBT as described above to any performance problems in your organization? (Please check the most appropriate response.)</u>

44%	YES, we have applied PBT principles or methods.
16	We have not applied PBT and have no plans to do so in the future.
20	We have not yet applied PBT, but we plan to do so in the future.
20	We haven't fully decided yet.

Thus, 64% of the responding organizations have already started using PBT or plan to do so in the future. It will be remembered that 30% of the participating organizations, prior to attending the workshops, were using some type of individualized instructional methods. Now, more than twice that number are using, or are planning to use PBT methods. Further, another 20% have not yet decided whether or not they will use PBT methodology.

It seems clear that the workshops had a significant impact on participants' attitudes toward and utilization of PBT methodology. Only 16% of the participants indicated complete absence of interest in applying PBT.

Further, at the time of this writing, the author has received information that several of the companies that had not yet applied PBT, but which planned to do so, have now allocated staff and budget and are starting to develop PBT systems for skilled trades training.

2. In the space below please name the jobs or occupational groups in the apprenticable or skilled trades to which you have applied PBT. Include all applications even if only to a single task or group of tasks. (Numbers equal percent responding.)

Electrician	(16%)	Industrial Truck Mechanic	(4)
Tool & Die	(12)	Jig & Fixtures	(4)
Machine Repair	(12)	Linemen	(4)
Machinist	(8)	Insulation Workers	(4)
Millwright	(8)	Plumbing	(4)
Welder	(8)	Hydraulics	(4)
Railroad Carmen	(4)	Pipefitter	(4)
Transportation Mechanic	(4)	Plant Maintenance	(4)
Auto Mechanic	(4)	Bldg. Service Mechanic	(4)
Pyrometry	(4)		

3. Please list all other jobs or occupational groups to which you have applied PBT.

Computer Technicians	(4%)	Instructors	(4)
Crane Operators	(4)	Machine Operators	(4)
Fork Truck Operators	(4)	Customer Service Clerks	(4)
Electronic Assemblers	(4)	Underground Repairmen	(4)
None	(25)		
No Answer	(43)		

4. To which types of training have you applied PBT?

25% Vestibule or on-the-job training (hands-on training).

17 Related training (that which is normally done in the classroom).

58 Both of the above types of training.

5. During the past year approximately how many trainees have received any part of their training using PBT?

1400 Apprenticable or skilled trades.

340 Other jobs.

As a group, participants in the workshops have applied PBT methods to a large number of employees in a wide variety of apprenticable trades and other skilled jobs. As previously indicated some of these organizations had been using PBT methods prior to attendance at the workshops. The majority of the schools and companies have applied PBT to both related instructions and on-the-job-training.

6. Have you developed, or are you planning to develop in your own organization the capability to design and implement PBT?

Yes 82%

No 18

The majority of the participants' organizations either have developed or are planning to develop their own internal capability to design and implement PBT systems. These organizations appear to be serious about using PBT methods in their skilled trades training programs.

7. Please describe briefly one or two of your PBT applications.

A full description of the applications reported by those organizations that have adopted PBT can be found in Appendix G. Only the instructional media and results will be summarized here.

Virtually all available media are being used including video tapes, task guides and on-the-job, live instruction. Programmed texts, sound slides and video tapes are the most commonly used media. Some organizations, however, are working with very inexpensive information sheets and work books.

Almost half of the organizations reported that it was too early to evaluate the performance or budgetary changes attributable to the use of PBT. Slightly more than half, however, reported the following effects of their use of PBT:

(1) A 10% reduction in equipment downtime.
(2) More productive apprentices earlier in their apprenticeships.
(3) Reduced scrap.
(4) Better safety performance.
(5) Better quality of work.
(6) Trainees move through program faster.
(7) Lower instructional cost per trainee.

Although the number of companies reporting results is not yet large, the positive impact that PBT is having where it is being used is encouraging. These results also offer further in-house verification of the results of the author's initial study of the application of PBT to apprentice training. They provide concrete evidence of the benefits to be attained through broad scale use of PBT systems in skilled trades training.

8. Describe briefly the PBT applications you plan or hope to make in the future.

Twenty-six percent of the respondents indicated they plan or hope to apply PBT to all apprentice training in their organizations. Machine repair, tool and diemaker and machinist were in the other most common planned applications.

As a group the respondents plan to apply PBT to a wide list of more than 20 trades, jobs or occupations ranging from entry-level jobs to cutter engineers.

These organizations appear to have ambitious plans. If they are able to carry out even a fraction of their current plans, PBT will enjoy widespread and broad spectrum application in the years ahead.

9. In general, how satisfied are you with the PBT applications you have made?

Very well satisfied	54%
100% satisfied	9
Yes	9
Fair	9
Too early to tell	18

The almost universal satisfaction with their PBT applications is consistent with the positive results these organizations are experiencing from use of PBT (see 7 above).

10. What are the major problems you have encountered or anticipate encountering in applying PBT?

The most common responses to this question were:

Time, money and personnel required to develop training methods	27%
Defining tasks and performance objectives	23
Supervisor and others' resistance to change	19
Union resistance	9

11. In what areas, if any, do you feel you need more help in applying PBT?

No answer	48%*
None	17
Defining objectives, task analysis, performance measurement	19
Development of training materials	14
More information or more seminars	9
Proof of value of PBT	5
Don't know yet	5

*In this and subsequent questions figures may add to more than 100% since respondents may have given several answers.

12. Who do you feel is the most logical or desirable source of the help you need?

80%	Your own organization
13	The U.S. government
13	State or local government
46	A trade or professional association. (Specify)*
7	Your local or international union.
26	Other. (Please Specify)*

*Illinois State Apprenticeship Conference
National Machine Tool Builders Association
American Society for Training and Development
National Tool and Die and Precision Machinery Association
Other training departments (in other companies)
Consultants
Technical schools

It is interesting that most respondents see their own organizations as their primary source of whatever help they need. Trade or professional associations are a close second choice. It is also significant that 26% of these organizations (predominantly industrial firms) feel that the state or federal government is or should be an important source of help.

13. If you have not applied PBT to any tasks or jobs in an apprenticable or skilled trade, please indicate why not?

(1)	Not enough apprentices to train	21%
(2)	Lack of time or other priorities	14
(3)	Don't have staff to assign to it	14
(4)	Existing training methods are adequate	14
(5)	We have started	7
(6)	Haven't yet got management O.K.	7
(7)	Needs further study	7
(8)	No answer	29

It is clear that the economic recession has had an effect on the training plans and programs of the companies and schools that attended the workshops. The second, third, sixth and seventh responses above reflect the necessity for advance planning and budgeting before PBT can be implemented.

14. If you have not applied PBT to any task or job at all, please tell us why not.

No answer	33%
Not yet ready	25
No staff to assign	25
Have other priorities	8
Union backlash	8
Present training adequate	8
Management decision	8

Apparently the reasons for not using PBT outside of the skilled trades are the same as those that apply to apprentice training in question 13, and they are related to factors other than the nature of the trades or apprenticeships involved.

CONCLUSIONS AND RECOMMENDATIONS

Based on the information collected from workshop participants, the following conclusions seem warranted.

1. In general, the 100 workshop participants from industry, technical colleges and the U.S. Department of Labor expressed positive attitudes toward both the workshops and Performance Based Training.

2. Industrial personnel were more positive and enthusiastic in their response to the workshops and to the value and utility of PBT than were the participants from the Bureau of Apprenticeship and Training.

3. The vast majority of participants felt they could recommend PBT for use in technical training.

4. The initial cost of PBT development and resistance from unions and management were seen as obstacles to widespread use of PBT.

5. Consistent with these attitudes 64% of the participants either have applied PBT or are planning to since attending the workshops. This is more than double the number who were using it prior to attending the workshops.

6. Their applications are across a broad spectrum of skilled trades and semi-skilled jobs.

7. Nearly three quarters of the companies and schools that have applied PBT are well satisfied with the results they have obtained. These include reductions in equipment down time, scrap, training time and training costs.

8. There seems little doubt that such workshops are an effective means of communicating and explaining innovations in training to industrial personnel.

9. There is also ample evidence that PBT is a valuable and effective training technique in skilled trades and other technical training.

10. In the light industry's interest in the use of PBT in apprentice training, we recommend that the U.S. Department of Labor respond to that interest by assuming a leadership role in helping companies convert to a training system based on demonstrated performance rather than accumulated hours.

    As labor and training cost spiral upward industry is going to be increasingly concerned with reducing training time and

costs and with measurable results from its training investment. The responses of the industrial participants in these workshops provide documented evidence of this trend.

As more and more companies begin to adopt performance based methods, the Department of Labor will find itself in the role of follower of this trend. We believe it would be more productive both for the U.S. government and for U.S. industry if the Department of Labor were to assume a leadership role and provide industry with the help it needs in developing apprentice and journeyman performance standards and a flexible system to achieve those standards.

The help provided could be in the form of: more detailed training workshops for industry on the procedures of PBT; a project to aid industry and unions to develop uniform, measurable performance standards for apprentices and journeymen; technical assistance in developing PBT materials in specific trades.

APPENDIX A

WORKSHOP PROGRAM

8:30 WELCOME and INTRODUCTION John Mandl, Training Director, National Machine Tool Builders Association.

OVERVIEW OF WORKSHOP Arthur E. Oriel, A E. Oriel & Associates, Ltd.

Mr. Oriel will provide an overview of the basic principles and techniques of Performance Based Training, its uses, limitations and benefits. He will also review the workshop schedule.

STEPS IN PERFORMANCE ANALYSIS

Mr. Anton will use case problems, flow charts and illustrations drawn from his own plant to demonstrate how performance deficiencies are identified, analyzed and classified and how decisions are made as to what actions are most likely to lead to cost-effective solutions. The emphasis will be on performance analysis in apprentice training and participants will be encouraged to identify and analyze performance problems from their own plants.

10:30 - 10:45 COFFEE BREAK

METHODS OF TASK ANALYSIS

Mr. Oriel will demonstrate that task analysis can be carried out effectively by the internal staff of most companies and usually, within available budgets. He will discuss different methods of conducting task analysis, and, using actual task analyses of shop math and machine tasks, will take participants through the steps involved in conducting task analyses. Participants' problems will be analyzed and methods of establishing performance objectives will be discussed.

MOTION PICTURE FILM

This fifteen minute film, produced specifically for these workshops, describes briefly but in graphic detail the Performance Based Training system, the steps involved in its development, the field tests conducted at Caterpillar Tractor Company, International Harvester and other locations, and the measurement of its effectiveness in improving performance and reducing training costs. It will also describe how Caterpillar has converted its entire training effort at one plant to this new method with no increase in training resources or budget.

12:00 LUNCH

PERFORMANCE BASED TRAINING AT CATERPILLAR

Nicholas Anton, Training and Safety Manager, Caterpillar Tractor Company, Joliet, Illinois.
Using a variety of audio-visual aids, Mr. Anton will describe in detail how Performance Based Training is being implemented in his company, the procedures involved, the training philosophy underlying the approach, budgetary and administrative requirements and the results being produced. Throughout, the emphasis will be on how participants may achieve the same results in their own companies.

SELECTING, DESIGNING and VALIDATING PERFORMANCE BASED TRAINING PROGRAMS

Both workshop leaders will discuss and demonstrate how to match available training materials to performance objective, how to evaluate commercially available materials, develop one's own materials and job training sequences, field test, revise and validate training programs and measure results and cost-effectiveness.

3:00 - 3:15 COFFEE BREAK

CASE PROBLEM ANALYSIS

The remainder of the afternoon will be spent in analyzing performance and training problems submitted by participants. Each participant will have the opportunity to apply to the training problem he submitted before attending the workshop the techniques of Performance Based Training and cost-benefit analysis. The emphasis in this afternoon session will be on helping participants learn how to use modern training methods in their own plants within the limits of their current budgets and training resources.

SUMMARY WRAP-UP

APPENDIX B

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APPENDIX C

WORKSHOP QUESTIONNAIRE

This questionnaire is provided so you can give us your opinions, not only about Performance Based Training (PBT), but about how we might make the workshops more useful and meaningful for participants.

We would like you to be as frank as possible in your answers. For that reason, the questionnaire is anonymous. You need not identify yourself, unless you want to.

BUT, PLEASE ANSWER ALL QUESTIONS AS COMPLETELY AND CANDIDLY AS YOU CAN.

The information you provide is essential to us in our efforts to help companies adapt Performance Based Training (PBT) to their own training and performance problems.

1. Now that you have attended the full workshop, we'd appreciate it if you would give us your concrete suggestions on how we might make the workshop more effective. Please write specific suggestions for each part of the workshop listed below. Consider content, speakers' delivery, audio/visual aids, and whatever else you may consider relevant.

   1.1 OVERVIEW OF WORKSHOP and PERFORMANCE BASED TRAINING (PBT)

   1.2 PERFORMANCE ANALYSIS

   1.3 TASK ANALYSIS

1.4 MOTION PICTURE FILM

1.5 PERFORMANCE BASED TRAINING at CATERPILLAR

1.6 SELECTING, DESIGNING and VALIDATING PERFORMANCE BASED PROGRAMS

1.7 CASE PROBLEM ANALYSIS

2. Now let's consider PBT as described in this workshop, and the varied forms of it that are in use in Caterpillar Tractor Co., Ford Motor Co., Lockheed-Georgia, DuPont and other companies and schools.

Listed below are some of the major characteristics of PBT. Please check the three (3) characteristics which, in your opinion, are most important in making the decision to implement PBT in industry or in schools. (CHECK 3)

___ It tends to standardize training. All trainees get the same instruction.

___ It is based on specific, detailed task specifications.

___ It capitalizes on individual differences in learning ability, thereby increasing its efficiency.

___ It attempts to hold performance constant while letting learning time vary.

___ It reduces learning time required.

___ It reduces instructor time required.

___ It has measurement of results built into the system.

___ Movement through the program is based on task achievement rather than time.

___ Other (Please specify.)

3. Having completed the workshop, do you feel you can now recommend to your own or to other companies that they use the methods of Performance Based Training? (We are referring here to the methods not to any specific materials.) Please reply in your own words.

4. Please describe briefly what you consider to be the major obstacles to the use of PBT in industry or schools.

5. Please describe briefly what you consider to be the major shortcomings of PBT as it is now being used in industry and schools.

6. Please use this space for any other comments you may have.

Thank you very much for completing this questionnaire. We appreciate your effort in providing us with your candid opinions.

PLEASE RETURN YOUR COMPLETED QUESTIONNAIRE TO THE WORKSHOP LEADER.

APPENDIX D

WORKSHOP QUESTIONNAIRE RESPONSES OF CHICAGO AND BOSTON INDUSTRIAL AND COLLEGE PARTICIPANTS

1. Now that you have attended the full workshop, we'd appreciate it if you would give us your concrete suggestions on how we might make the workshop more effective. Please write specific suggestions for each part of the workshop listed below. Consider content, speakers' delivery, audio/visual aids, and whatever else you may consider relevant.

1.1 OVERVIEW OF WORKSHOP and PERFORMANCE BASED TRAINING (PBT)

Excellent.

Information received can be used in other areas.

I feel that for the person who has the responsibility for training in any type of training situation (machine-tool, construction or service trades), that this presentation was most effective, especially on an introductory basis.

Good solid summary of purposes and objectives.

Very informative. A two-day workshop may be considered. (A vast amount of material for a small period of time.)

Good -- about right timing and depth.

Very good. Excellent presentation.

I feel the program is more related to production activities than service activities.

Content: Good
Speaker: Good
Visuals: Good

Does not require change. Excellent.

Very good.

Enlightening. Many of the ideas expressed here will be implemented by me this year.

Excellent workshop -- covered the PBT system extremely well.

Good -- did not see or hear what limitations of PB.

Presentation is excellent.

Excellent.

Consider a little more background as to the study conducted by A.E. Oriel & Associates. What was it, results, when, etc.

Very good.

Workshop excellent vehicle to disseminate information -- well presented. PBT concept extremely interesting, appears to have considerable potential.

Very good.

Excellent -- I am very interested in PBT. I would like further information.

Very well presented. A/V aids extremely good. Need more!

Excellent!! Concept is long overdue.

Thought provoking! Try to keep politics out; spend more time on how to!

Good introduction.

This training session has been very informative for we are in the beginning stages of evaluating training on the basis of performance and training results.

No recommendation for improving the workshop. All three speakers presented their respective parts of the program in a professional manner.

More practical examples would be helpful, however, program was extremely helpful to me.

Good use of handouts and A/V. Speakers were knowledgeable so as to adequately handle the broad topic.

Okay.

1.2 PERFORMANCE ANALYSIS

More hands on "doing".

Believe it could have explored more specific types of measurement, i.e., time, quality of work, variety of assignments, etc. to give better picture of how perfect standards can be set up.

No suggestions.

Very good. But more depth and examples might be helpful.

Very good. Excellent presentation.

Good approach. We are presently taking similar approaches on video tape but not on a formal basis.

Short, but good.

Not complete enough, human factor.

Very good.

Delivery good, but material not new.

Presentation geared to production type plants.

I would need more time to see the plan in action to add constructive criticism.

Good presentation -- need more help on this.

Okay.

Excellent approach to education.

Excellent concept for providing progressive and understandable methods of training disadvantaged adults.

This can be the only way to guarantee the quality of instruction of tomorrow.

Will be implementing these principles as soon as possible.

Good basic introduction.

Very helpful. Our goal is to establish a skills library with the purpose of performance behavior change or as we say improvement.

No recommendation for improving the workshop. All three speakers presented their respective parts of the program in a professional manner.

Good blend of presentation and interaction with participants.

Blended concepts with specific examples so that understanding was achieved.

How about sample forms.

1.3 TASK ANALYSIS

More hands on "doing".

All material, presentation, etc. was well done. Only criticism is digression into EEO selection and testing. Interesting and relevant to other problems, but not really part of this program except as using completion of performance base course as criteria.

One necessary element in training any apprentice is basic knowledge of major product of the firm and the operations involved not just the apprentices particular job, but the relationship to the whole.

I feel that for the person who has the responsibility for training in any type of training situation (machine-tool, construction or service trades), that this presentation was most effective, especially on an introductory basis.

Excellent coverage of the principles of a very complex technique. Time did not allow us (the attendees) to go through a sample of our own, which would have helped clarify the technique. I liked the format.

Utilize an example from start to finish having the class participants in the process. (Performance based training of performance based training.)

Excellent overview and handouts! Would like all my staff to have it.

Very good. Excellent presentation.

Good approach. Will attempt to institute back on the job.

Added a new dimension to my training knowledge. Would like to have viewed an actual program complete with audio, etc. (i.e., a demonstration perhaps using a workshop member).

Does not give level of work required to achieve perfection.

Excellent.

Delivery good. A new logical approach to defining job content. Useful.

Good. Best part of workshop.

I would need more time to see the plan in action in order to add constructive criticism.

Good presentation -- something industry has to emphasize more.

Okay.

Excellent.

A necessary step in the analysis. This seems to be the only way to provide some type of logical basis for selecting training methods, time, costs, etc.

Something that must be accomplished to determine what, when, how much, and under what conditions instructional content must be. This is the best method to eliminate superfluous material. Too long, too often, time criteria has been the standard and through utilization of Task Analysis, this can be demonstrated as a faulty method.

Will be implementing these principles as soon as possible.

Good basic introduction.

We are doing this now.

No recommendation for improving the workshop. All three speakers presented their respective parts of the program in a professional manner.

No recommendations for improving the workshop. Extremely well presented by the three presenters.

Good blend of presentation and interaction with participants.

Very good overview which served to update me tremendously.

How about sample forms?

1.4 MOTION PICTURE FILM

Okay as part of the program. Won't stand on its own without experienced speaker.

Very good.

Good -- but a few too many shots of individuals standing around the shop.

Use with process of task analysis.

Was a nice break but wasn't overly impressed with content.

Presented in a very interesting manner.

Good as is -- a very useful tool.

Not complete enough; lacks further exposure.

Good.

Not needed. Added little to program.

An excellent film on PBT and if available I would like to borrow it to show to our management.

Good -- did its job.

Good film.

Good -- interesting brief film appropriate for introductory work.

Excellent.

Too short.

Very good. I would like to borrow this.

Good! In fact, I intend to borrow it.

Very good. Can this be made available to general public, schools, industry, etc.?

Very good. Would like to use at our plant.

Good.

Good short opener to support performance/time.

Helpful as overview.

Good introduction. Probably could have been more useful at beginning.

Very good.

1.5 PERFORMANCE BASED TRAINING at CATERPILLAR

Good manner -- got great empathy with group.

Interesting.

Made a believer out of me, as far as being able to do a better, quicker job with present staff.

Indicate "how-to" initiate program and prepare selling of such to management.

So-so. Didn't seem to come from as deep speaker knowledge base as Art Oriel -- but good to have one of the implementers present.

Very good.

Performance guides is better method as audio visual equipment tends to have a high degree of downtime.

Good, but point out the caution that must be considered before doing it. Communication is very important with I-E Dept, incentive, etc.

Good program.

Good.

Added credence to the PBT theory. If it is working there, it may work elsewhere.

It appears that Caterpillar is having great success with PBT. I would like to have heard of some of the problems they encountered, if any, with trainees involved in the program.

Based on $ for a production type industry.

Good presentation. Would be helpful to see results from some other companies.

Impressive.

Okay.

Am familiar with this program.

Glad to see that someone is concerned about good and effective training.

A good start -- I'm glad I have found some ally.

Received some basic cost cutting ideas.

Good. Should act as a leader for other companies and educational institutions.

Good case sample. I 11 be interested in the end result in 1 year, 2 year, etc.

Very helpful.

Useful as specific example helped to bring out theory.

Well done -- would like to see some sample materials in handouts.

1.6 SELECTING, DESIGNING and VALIDATING PERFORMANCE BASED PROGRAMS

Up to individual. If they had specific question -- they got specific answer.

Good information.

Excellent outline of steps required for an effective program.

Indicate in more detail the necessary steps required.

More information!

Very good.

Good judgement and study required for one to one or group sizes.

Excellent model.

Not complete. Lacks true outlines of program.

Very good.

A "how to" system of setting up PBT. May be beneficial in the future.

Good information for any company.

Go deeper in this area. Could cut a little from items 1.2 and 1.3.

Needs more of validating.

Okay.

Very effective approach.

Another good point. Validation is necessary to have justifications for implementation.

The only way to fly!

Have special workshop.

This subject could be a seminar alone. I still see validating as the big problem.

Needs elaboration, possibly a small case problem.

Could have elaborated more on this area but time constraint was a factor.

1.7 CASE PROBLEM ANALYSIS

Good.

Not enough information.

Went through it too fast to get much out of it.

Very good. No suggestions for improvement.

How about a little learner activity in filling out a cost/benefits sheet? Good overview though.

Very good.

The use of video tape programs. The use of programmer instruction materials. Development of a Cost Benefit Analysis.

Good.

Good example.

Good.

Helped me understand "how to" develop Cost-Benefit Analysis.

Need more time to use case to develop questioning by participants.

Not too helpful. Would rather see more on 1.6.

Good idea. Too bad we didn't really come to a final conclusion on the case in question. I would have liked to see a case or two more discussed in this way.

Okay.

Good.

Fair.

Impressive, but how do I convince my superiors?

Good introduction.

Okay.

Good aid.

5. Having completed the workshop, do you feel you can now recommend to your own or to other companies that they use the methods of Performance Based Training? (We are referring here

to the methods not to any specific materials.) Please reply in your own words.

Yes. Relevant to mechanical training, but also operator/ supervisor training -- all to increase productivity.

I intend to try some of these methods in a specific area and see what happens.

In specific production plants the system should be excellent but extremely limited in trades such as electrician and plumber, etc. (contractors).

Some methods can be adopted without delay in various trade programs.

Yes, but then we have been preaching this (with not very effective results) for some time.

Yes. The standard methods clutter learning. The presentation pointed many areas to zero in on conformity in our attitude toward training.

Yes, but could already before attending. Feel general training manager with no background prior to coming would be able to.

I feel that the method presented today provides a very sound approach to training and we will be pursuing this method. I also feel that other companies should have a chance to be exposed to this system.

In some applications but not every program. I cannot visualize for field training on service operations.

Yes.

Yes, but with some changes in outlines.

I believe we can adopt these methods to construction crafts.

Yes, PBT readily applies to our company's training plans.

Yes, it allows trainees to progress at their own pace and will cut the standard time allowed for a trainee.

Yes.

Yes, I would like to see the programs in operation in order to have a better handle on priorities as to where I would start in my shop.

Yes, however, it will be some months before we can again start a learner program.

Yes. I feel it is only a matter of time until PBT will be a must to survive.

Yes.

Yes.

Yes.

I want to do further investigation.

Yes. To be consistent with OEO objectives, performance education evaluation seems to be the only answer.

I have been trying to convince both industry, B.A.T., and my school officials that a criterion-referenced totally individualized variable entry-variable exit program for apprentice training is the most cost effective way.

I would recommend it but I want to get more information on it myself.

I see merit. Worth investigating in more detail.

Yes. I agree on performance over time. I've called it results. Training result most important.

Yes. However, there are other training methods which should also be considered and should not be excluded for PBT exclusively.

I believe Performance Based Training is the way to go and our company is moving in that direction.

Qualified yes. There are other training methods that deserve further consideration before accepting PBT one hundred percent.

Yes, I think it can be very useful in many ways to all sizes and types of companies.

Yes, in fact, I will try to implement in basic courses since there definitely is a need.

We are working in this direction.

4. Please describe briefly what you consider to be the major obstacles to the use of PBT in industry or schools.

Habit of time sequence. Degree of job loss if learning curve accelerated.

Confusion as to ultimate goals of programs. Are we trying to produce a whole man or a single purpose man? I agree with you that competence to do something comes first. However, the concept of hand, head and heart which is in our Apprentice School logo is still valid!

Basic education in schools has lowered the caliber of apprentices. Industry should not be responsible for teaching the fundamentals, i.e., 3 R's, but an apprentice who cannot read is a grave problem.

Proof of finished product.

Industry: fixed training schedules dictated by union contracts and cost of changing these. Schools: rigor mortis.

Change, per se.

Opposition to change. Justifying front end costs.

Attitudes: we have become comfortable with "conventional" methods.

We are presently using Xerox learning systems, plant engineering training systems, and video tape which is a similar system.

Management resistant to change.

Funding.

Selling idea that existing methods are not adequate to times.

Union resistance/misunderstanding of PBT. Resistance to "cherished" methods of instruction/training.

Justifying the cost reduction in a trainee's inefficiencies during the learning process. The possibility of flack from the union where companies have incentive standards.

Training in the 3 Rs of people now coming into the work force.

Industry such as ours in low turnover of help difficult to justify cost. Would be great in schools to establish and meet functional needs.

Selling the program.

People. Change is difficult.

The established system or custom of so much time "should" be allowed for someone to learn such and such a subject.

In my own case -- simply unfamiliar with concept prior to workshop. Should be implemented.

Acceptance.

Obtaining good materials.

Lack of equipment. Limited budget.

The changing of established procedures.

Tenured college professors and training directors who have the misconception of risking job security. Initial cost outlay -- this, in community allies, would have to be federally or state funded.

Convincing management to allow time and manpower to develop programs.

Time, resource people, funds and support at all levels (industry, government education).

Breaking with union and some management on time concept.

Political and economic consideration.

Union resistance. Government regulations.

Political and economical.

Difficult to establish specific, measurable criteria in conceptual type positions or courses.

Resistance to change based on security, politics of organization and economics.

Instructors holding on to traditional methods.

5. Please describe briefly what you consider to be the major shortcomings of PBT as it is now being used in industry and schools.

Ignorance -- it exists.

Applicability to job shop operations. In our business, we approach a construction type of operation. Workers do much work independently.

Possible limitation of objectives, i.e., machinist instead of tool and die maker or T&D limited mostly to one particular field.

Will it motivate the average type individual as it should?

Ineffective application resulting from union resistance. Expense of rewriting and redeveloping many existing programs.

Proper identity as to is it PBT or standard training being used.

Lack of experience of course developers and managers.

Don't know.

In schools it is a good approach. In my opinion industrial application would stimulate grievances.

As now being used -- a lot of performance based training really isn't.

Does not reach enough of the trainable individuals.

None at this point -- perhaps it hasn't been totally validated because it is so new.

Changing of old time employers to new concept.

Cost to implement, i.e., it involves a major change in philosophies and methods that have not been well measured in either cost or effectiveness.

Unwillingness to accept a new idea!

A uniform system of goals or objectives for the PBT programs. This causes too much variation between programs.

Not familiar with cases currently using PBT.

Not enough flexibility.

I do not have enough information to evaluate this statement.

Too specific in schools.

Not enough clarification as to the what and how of its use.

Lack of motivation of students -- no long range test-retest validity to ascertain retentivity.

Still linked to time.

Expense implementing and more detailed evaluation system.

Validity. Performance test agreement on what they should be.

No problem with PBT. Problems are with industry and schools failing to use PBT.

There is skepticism on the end product by those schooled in traditionalism.

With PBT approach, there is no problem. Problems arise from people (unions non-acceptance) industry and educational institutions not cooperating freely for various political or economical reasons.

Lack of awareness by top management.

Lack of properly designed standards. Improper implementation procedures.

1. To much "passive" (A/V) material being used.
2. Instructors not following recommended procedures.

6. Please use this space for any other comments you may have.

Excellent seminar. Relevant and timely. Trust Department of Labor will use same method to get information out to the field on such relevant studies.

Excellent and interesting presentation.

Job well done by Art and Nick.

Very worthwhile seminar! Thanks for the invitation.

I feel that this system has tremendous potential and should be presented to the trade association people and other groups that could influence its continued development.

It is my opinion the application is good for production type industries such as machine shop, assembly, etc. Maintenance and service operations present problems.

Your program was excellent and I feel gratified to have attended.

I have gained considerable knowledge regarding performance training.

Other examples would be beneficial. Examples of PBT at IBM, Lockheed?

I would liked to have seen some percentage figures on the success and failure of the trainees under the PBT system.

I believe I must get into the whole of the program in more depth. The initial introduction is very exciting.

Consider better arrangements of handout material to participants of this program. Put in order.

In the area of visual arts, I would have liked to have seen a breakdown sheet similar to the one we received for "lack of knowledge or skill" from the "desired job performance" sheet on the other subject listed there of "lack of execution." Also, I would have enjoyed being able to return to work with a sample cost benefit analysis sheet to show my boss. Did the references mentioned during the workshop appear in the bibliography we received in our workshop materials?"

If they did we might have saved some time by simply referring to this bibliography when reference materials were asked for.

Feedback to industry and schools on Labor Department studies should be improved.

It was a mind expanding experience.

We were told our travel costs would be reimbursed -- we are uncertain of procedure for making claims.

I have been developing, directing and implementing individualized instruction for the last seven years. I welcome your ideas and concepts. Keep up the good work.

Lunch period too long! Hot!

Make these programs available for more people on a more detailed basis.

This program has been very timely in presenting a few new ideas on performance and task analysis.

I like the fact that important research supported by the Government was made available. Such feedback should be encouraged in other research projects and should be publicized more.

Felt that workshop was most valuable and agree that further dissemination of information is required.

Need more specific help on setting up performance standards/ testing.

APPENDIX E

WORKSHOP QUESTIONNAIRE RESPONSES
DEPARTMENT OF LABOR PARTICIPANTS

1. Now that you have attended the full workshop, we'd appreciate it if you would give us your concrete suggestions on how we might make the workshop more effective. Please write specific suggestions for each part of the workshop listed below. Consider content, speakers' delivery, audio/visual aids, and whatever else you may consider relevant.

1.1 OVERVIEW OF WORKSHOP and PERFORMANCE BASED TRAINING (PBT)

Excellent -- well paced. They told their story efficiently and interestingly. Anybody could get the general message.

Okay.

For purposes of making presentations to apprenticeship audiences, the examples and materials might be more directly related to apprenticeship training.

Overall workshop is of significant value.

I think this was a good workshop and it will be of use to me.

Not bad. Could be improved upon by getter quality pictures and eliminate time lag between pictures and lecture more pertinent information.

Perhaps when the department decides what it would like BAT staff to get out of these sessions and what use it would like BAT to make of this information, it will be possible to make a task analysis of what we need to know and on that basis to define a program package of institutions which could then be evaluated on the basis of how well we learned what we need. Meanwhile, I think we had an able exposition of the items.

Too much material to cover in time allotted. The concept makes a great deal of sense.

Informative and in some respects a new approach to training. I believe the training system works best in training specialists as opposed to journeymen.

Too much material not really relevant to the subject was included.

Okay.

As a comparative method, it is thought producing, however, an evaluation should receive more thought.

Very good information to work with.

Okay.

It very definitely has a place in apprenticeship. It can be uniformly applied and therefore enhance the program.

Believe the emphasis was more on trainee than apprenticeship. If given to management specialization without full term apprenticeship might be the lasting impression.

Good.

Seminar presents capsulized but sufficiently complete information to learn the concepts and mechanics at the system. This could be improved by working of samples from provided problem situations.

Very good.

Well done.

The system is indeed a means to be beneficial to training programs. It is a new step to improve training and cut cost.

This is the first workshop that I have attended in ten years that I would class as very good.

Adequately explained.

Excellent.

Good.

Very good.

Very good.

Good.

Well organized and material was presented in a very excellent manner.

Good.

An outstanding presentation; enlightening and an aid in furthering the need for apprenticeship (regardless of length of time).

After digesting -- a better knowledge would be gained.

Good.

Innovative -- updated.

Should have more workshops like this one.

Excellent.

More.

Tried to conserve too much in time allotted.

Excellent background knowledge is very evident.

Excellent presentation, but I feel you need more than a six presentation.

Excellent.

Very good.

1.2 PERFORMANCE ANALYSIS

Okay.

Okay.

As meant for information, good. If applied to an apprentice, invaluable. If tests are not acceptable Do Not Use At Any Time.

Most of BAT staff is familiar with the mechanics of performance analysis. Time allotted was sufficient.

A necessary operation in order to have a successful and efficient training program. I am sure many programs would benefit by following this procedure.

Nothing really new; some terminology different.

In detail -- okay.

I feel this should be used more in all types of education.

Good.

Should be a part of the work processes as a new approach.

Excellent presentation -- no changes suggested.

Well explained.

1. M.B.O. must be related.
2. Individual behavior must be accounted.
3. Cost factor = #1 & #2 working conditions.

A very useful system. If utilized can improve training and provide a cost savings.

Good.

Excellent presentation.

Excellent.

Good.

Excellent.

Very Good.

Good.

Excellent presentation and very enlightening. This information will be very useful in selling training to firms who presently are not training but are in need of some.

Good.

Good.

Objective.

Will help to sell apprenticeship.

Excellent.

More.

Good

Explained well from standpoint of savings in time and costs -- and proves itself on basis of logic.

Question whether it is practical for the smaller employer.

Informative and well presented.

Very good.

1.3 TASK ANALYSIS

Okay.

Okay.

This procedure could usefully be adapted and applied to development of apprenticeship work processes.

If all operations are done systematically with positive thinking.

It is a very good way of evaluation of the system of training. However, if only part is adapted -- useless.

Most of BAT staff is familiar with the mechanics of performance analysis. Time allotted was sufficient.

Can best be described as a refined system of performing a job we have always done to some extent in developing new programs.

Nothing really new; some terminology different.

Detailed. Okay.

I feel this should be used more in all types of education.

Too time consuming, but very useful.

Should be a part of the work processes as a new approach.

Reference to TA's done prior to this research was not relevant and was time consuming. (Constructive criticism.)

Okay.

Another valuable tool to improve upon training. It seems that this would be the foundation of a good performance based program.

Good.

Completely explained.

Good.

Excellent.

Good.

Good.

An excellent presentation and very enlightening. This information will be very useful in selling training to firms who presently are not training but are in need of some.

Good.

Good.

Relevant; important.

Should have more workshops like this one.

Good.

More.

Good.

Step by step, complete in every way and speaker was careful to indicate need for proper administration of program for expected benefit.

Practical considerations would include the availability of time of a company representation.

Excellent.

Very good.

1.4 MOTION PICTURE FILM

Okay.

Film was great -- projector needed oiling -- the noise was a distraction and did not do film justice. Never depend on the other guys equipment. It's usually in sad shape. Always check out audio/visual equipment beforehand.

Relates to type of training that is to be performed.

Motion picture good -- stills are mentioned above.

Slides were readable but movie was of poor quality.

Effective.

Didn't go as far as it could.

Okay.

Not explicit enough.

Some shots (of people sitting at desks) not necessary.

Only in spot instances and on needed emphasis.

Excellent.

Good.

Film was good overview of system.

Okay.

Interesting and informative.

Very informative -- helped to understand the system better.

Good.

Good.

Good.

Good.

Good.

Good.

Good.

Good.

Good.

Very good.

Realistic and to the point.

Good.

Fair.

Good.

Good.

Very good.

Clear and concise.

Very interesting.

Good.

1.5 PERFORMANCE BASED TRAINING at CATERPILLAR

Okay.

Okay.

This works fine in a company with a large work force. I do not believe it works with anybody who applies to less than 25 workers.

It would have been better in my opinion to use a BAT registered program if available. Wages selection procedures not really acceptable and A.A.P. without knowing how you would react to 100 appr. & 300 candidates (grey area).

My understanding of how PBT is used in the vestibule training to impart basic metal working skills sounds practical.

Good presentation and certainly informative.

Well presented.

Okay.

Information is sparse, not enough evidence or length of time in operation to truly evaluate.

I feel the training given here is production trainee. If the apprentice becomes a full journeyman he must be doing study and other things on his own.

Okay for Caterpillar. However, what works at one place may not work somewhere else.

It has good start -- more should be done along these lines.

Excellent presentation from Mr. Anton. Full acceptance by Caterpillar in itself signifies the value of PBT. Written evaluation at a later date with specifics of number entering, background of trainees or apprentices, dropouts, successes, etc. would be helpful to BAT ATR's as a potential promotional tool.

Good.

Impact could be reinforced by giving figures or approximations of monthly t.e but dollar advantages.

Divide in two parts: production shop and job shop.

A good approach to training for their operation.

The training concern of management seem to be to cut training cost and increase production. Nothing wrong with this if the training will provide a high quality of journeymen.

Good.

Very well presented.

Excellent.

Good.

Good.

Very good.

Good.

Very good.

Very good.

Well put together.

Good.

Productive -- profitable.

Learning what other companies are doing.

Good.

Good.

Well done.

Good.

Informative; excellent presentation.

Very good.

1.6 SELECTING, DESIGNING and VALIDATING PERFORMANCE BASED PROGRAMS

Okay.

Okay.

I believe this for stereotype operation.

It seems as though we could use more explicit, perhaps more visual aids.

Lack of BAT's knowledge in training design and training hardware is a problem.

Received some new ideas and approaches to training.

Complete and logical.

Very time consuming and could be very expensive.

On selected programs -- depending on the size of the program mainly.

Okay.

Okay.

The performance and task analysis results would be the basis for selecting and designing a program.

Good.

Some additional time should be devoted to this.

Excellent.

Good.

Good.

Good.

Very good.

Good.

Time is needed to evaluate more programs.

Good.

Uncertain results.

Very good.

Poor -- too little time to understand it completely.

More in depth study.

Wish we had more time on this subject.

Very good.

1.7 CASE PROBLEM ANALYSIS

Okay.

Okay.

I believe it was very well done.

More time should be spent!

Material content good, presentation good.

Okay. Good by Anton.

This should be part of the program for better results.

Not covered.

Okay.

Good.

Excellent.

Excellent.

Good.

Excellent.

Good.

Good.

Good.

Time is needed to evaluate more programs.

Good.

Good.

Poor -- too little time to understand it completely.

Very good.

Wish we had more time on this subject.

Very good.

3. Having completed the workshop, do you feel you can now recommend to your own or to other companies that they use the methods of Performance Based Training? (We are referring here to the methods not to any specific materials.) Please reply in your own words.

Yes. Perhaps government agencies can use PBT.

Yes. This is an excellent method. It needs time to catch on -- good missionaries and salesmen are needed to promote this fine product.

This system appears to be adaptable to apprenticeship and could be useful to small programs if it could be packaged in appropriate form.

Not to the best of my knowledge. I would need more material on ability.

Yes, because it provides a means of making training more effective.

In essence yes, but not in entirety.

I would recommend a review of training in the light of a performance analysis.

Yes!

Not universally -- in specific cases only.

Yes.

No -- the visual aids are important as aids but having to deal with people takes some personal touch.

Yes. Many large companies can use this type of training procedure and most can use some of it.

Yes -- I can!

Yes -- because I have assisted in task analysis and establishment of a basic same approach which is EFFECTIVE.

Yes, I believe this to be a more effective method than the conventional.

We have definite products (reports, etc.) to produce as well as provide services. Personality and other tangibles are more operative in providing service. System greatest value would be in the product area.

Yes, I think the method is very good.

Yes, I think the system should improve any training program.

Yes.

Not being an owner my function would be as a consultant or possible adviser.

To a certain degree.

Does not apply.

Yes.

Yes -- more productivity less spoilage material better trained employees.

Yes.

Yes! The methods are very effective.

In most cases, yes.

I believe that the program would benefit any company. Provides concrete measures as to training augments.

Yes.

No, program too new to determine overall results.

Yes.

Would take considerable time to sell others.

Yes.

4. Please describe briefly what you consider to be the major obstacles to the use of PBT in industry or schools.

In industry -- it's hard to teach an old dog new tricks. In schools -- educators abhor practicability and common sense and fear of being replaced by teaching machines.

Probably expense of adapting system for wide range of tasks, particularly for small firms.

Cost and type of operation.

I think small shops or firms may find problems in using the system because of not having personnel available to put into operation.

Dual system which will be hard to rub out even in this type of education.

A system which is not based on performance criteria resists the insecurity which performance criteria appear to introduce.

Lack of program designers.

Lack of motivation -- difficulty of selling new method no matter how good.

Okay for industry.

Automatic -- dehumanizing.

Time consuming and expensive.

None at this point.

Basically the hard position of tradition by management and labor to historical ways of training -- unfortunately.

In large industrial settings I believe it most effective. In smaller industries would require changes.

Overcoming traditional concepts.

Education foundation must be considered if not interational then separate but equal educational opportunities.

Can't think of any. I think it should be well received.

Facility and cost.

Construction trades.

Overcoming archaic, outmoded methods not adaptability to present day conditions.

Small industries cost factor based on Caterpillar Tractor Co. program. Schools -- change thinking of directors.

Educators.

Convincing people of new instruction methods.

Wages at end of term.

Economics of performance level attained too early by trainee.

Company time -- small company.

High costs.

Too much detail.

Cost.

5. Please describe briefly what you consider to be the major shortcomings of PBT as it is now being used in industry and schools.

In industry -- none that I can think of.
In schools -- it's in the hands of educators (God help us!)

I have not heard of any pros or cons on this type of training.

None of the firms with whom I work now use it but one of the obstacles will be with schools, in my opinion. These curriculum are not flexible either in content or scheduling.

The concensus it has not been used enough to evaluate.

I could not say. It is my impression that it is not widely used.

Appears to lend itself to large production oriented shops and not to small job shops.

Nothing was discussed regarding the personal feelings of my trainees, e.g., would the slow trainee blame the system?

Automatic -- dehumanizing.

Industry can train for their own operation, however, many trades must train their apprentices to be able to operate for many employers.

None at this point.

Administrative personnel in policy making positions who can block even a pilot project.

I am not aware of schools or industries in my geographic area that use PBT.

Not enough knowledge to comment.

Not complete -- should be a major item. This is in schools and industry hand in glove situation.

I don't know how widely it is being used.

Not enough information to give a qualified analysis.

None.

No comment because I do not know of any company in existence in this area.

No comment.

None to my knowledge.

New ideas.

None.

No monetary incentive for trainee to advance at a rapid pace.

Unknown.

6. Please use this space for any other comments you may have.

Don't turn off air conditioning so you can be heard use microphones. Don't allow smoking especially when "No Smoking" signs are posted. Think of non-smokers comfort especially when air conditioning is turned off. Creature comforts are important.

I have no specific comments regarding the items listed above. However, I enjoyed the presentation and learned much more about the problems of training in general, and how PBT can help solve some of them. Both Mr. Oriel and Mr. Anton made good presentations and held the interest of the group. The motion picture of field tasks at Caterpillar is very good and draws keen attention. Overall, I think this is an extremely good presentation of a worthwhile R&D project.

Task analysis adapted to programmed training aids understandably eased the training process in the specified training areas and for the specified machinery. Also, performance measurements were identifiable and calculated. The seminar illustrated these points very well. Both speakers presented their sections in a most commendable and relaxed manner.

However, the aids were limited to initial or basic instruction it appears, and as the student progresses to job complexity, greater reliance for instruction is placed back with the tutor. The program aids nevertheless are marvelous introductions wherever they are available and programmed for the type of training needed.

My problem is conceiving that it is more economical to amortize the cost of program aids, including cassettes, slides, flipcharts, etc., constantly adapted to changing work operational requirements, than it is to utilize competent instructors able to cope with changing designs and conditions.

Where the instruction is limited to that which formerly was referred to as related instruction, then the modern aids might far surpass an incompetent instructor. Where

the instructor and the modern aids were available, then the progress of the students should be at an advanced pace.

More importantly, it is noteworthy that Caterpillar Tractor Company will assess the value of the methodology in the profit and loss arena and their findings will no doubt prove the worth of the methods.

The material which you put forth that day is by no means conventional, and, as you probably recall by some of the questions I asked, it would shake up our entire training system if we were to adopt such a plan without first studying the effects it would have on industry and people involved. However the concepts of the workshop are, I think, quite clear in my mind, and probably we'll find that if such concepts are feasible we will certainly initiate same. Thanks again.

It was a well presented seminar. I think cost should be mentioned for this type of change over.

I enjoyed it.

Both speakers were articulate, however, a bit of humor would remove the dry lecture system.

This course is for industry.

I believe a time lapse of three to four years of usage must be documented before this system can be fully documented and analyzed.

I feel BAT should use it to improve our program.

I personally would like more exposure to PBT.

Room was too warm. Presentation was logical and lucid.

People of all communities should be brought up as to PBT and in coverage the youth to take advantage.

It would be more helpful if the questionnaire was completed after each phase of the presentation. When delaying your thoughts until the end you tend to skip some important thoughts.

Very good.

Pilots are skilled.

A well presented seminar by Oriel, Anton and Mandl.

Good session.

Enlightening.

All around presentation excellent.

APPENDIX F

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FOLLOW-UP QUESTIONNAIRE

The purpose of this questionnaire is to gather data on whether and how your organization has implemented the basic principles and methods of Performance Based Training (PBT) since the April, 1975 joint workshops.

You will remember from those workshops that PBT has the following characteristics:

1. It is based on detailed behavioral objectives and task specifications.

2. It utilizes individual differences in learning ability through trainee self-pacing.

3. Movement through training is based on task achievement rather than hours of training time.

4. It attempts to hold performance constant while allowing learning time to vary.

5. It has measurement of results (actual change in performance) built into the system.

With that introduction we ask you to complete every question to the best of your ability. If you are no longer responsible for these activities in your organization, please have the person who is now responsible complete the questionnaire.

Remember, we are interested in the extent to which your organization has applied the above principles and methods, not in whether you have used any of the specific materials or training tools discussed in the workshops.

1. During the past year have you or your organization applied any of the principles and/or methods of PBT as described above to any performance problems in your organization? (Please check the most appropriate response.)

   (a) ___ YES, we have applied PBT principles or methods.

   (b) ___ We have not applied PBT and have no plans to do so in the future.

   (c) ___ We have not yet applied PBT, but we plan to do so in the future.

   (d) ___ We haven't fully decided yet.

2. In the space below please name the jobs or occupational groups in the apprenticable or skilled trades to which you have applied PBT. Include all applications even if only to a single task or group of tasks.

3. Please list all other jobs or occupational groups to which you have applied PBT.

4. To which types of training have you applied PBT?

___ Vestibule or on-the-job training (hands-on training).

___ Related training (that which is normally done in the classroom).

___ Both of the above types of training.

___ Other (please describe).

5. During the past year approximately how many trainees have received any part of their training using PBT?

___ Apprenticable or skilled trades.

___ Other jobs.

6. Have you developed, or are you planning to develop in your own organization the capability to design and implement PBT?

___ Yes. ___ No.

7. Please describe briefly one or two of your PBT applications.

(a) Type of job or task. _____

_____

(b) Number of trainees. _____

(c) Media and methods used. _____

_____

_____

(d) Measurable performance or budgetary changes that have resulted.

_____

_____

APPENDIX G

FOLLOW-UP QUESTIONNAIRE RESPONSES

7. Please describe briefly one or two of your PBT applications.

(a) Type of job or tasks. Air conditioning.
(b) Number of trainees. 100.
(c) Media and methods used. Books, slides, air conditioning in shop.
(d) Measurable performance or budgetary changes that have resulted. None at this time.

(a) Aerial Devices Operators Training.
(b) 100 approximately.
(c) Programmed Learning, Visual Aids, "In House" Developed Video Programs.
(d) Difficult to determine due to lack of previous information, however there has been an approximate 10% cut in equipment downtown.

(a) Plumbing-Pipefitting.
(b) 150.
(c) Task Guides -- Booklets.
(d) A more productive apprentice early in the apprenticeship.

(a) Four Basic Machines. Specific tasks developed for each machine.
(c) Journeyman, supervisor and instructor.
(d) Not available.

(a) Training course design and development.
(b) 35
(c) Some A/V -- mostly self paced text.
(d) Difficult to project at this time on this project.

(a) Machine operation, assembly techniques, metrics.
(b) Varies with subject and production consideration.
(c) Programmed texts or sound-slide programmed instruction with trainee response capabilities.
(d) Reduced scrap charges, better safety and injury record, lower instructional cost/trainee.

(a) Engine rebuild in transportation mechanic program.
(b) 24
(c) Classroom instruction, slides, workbook.
(d) Students finish at different times allowing them to move on to other areas.

(a) Laying off tanks for installation of LNG insulation and secondary barrier.
(b) 8.
(c) Mock up of tank. VTR of complete operation in mock-up.
(d) Not completed yet.

(a) Welding band saw blades cutting spur gears.
(b) 100+
(c) Information sheet, demonstration, textbook, filmstrip, student participation (must weld a band saw blade correctly) must build a spur gear to specifications.
(d) Quality of work; cost (time required to do job).

(a) All machine operations.
(b) 450
(c) S/S, Videotape.
(d) Initial offset cost high -- program too new to measure performance.

(a) Cutter engineer. Specialized product (training available from within only).
(b) 2 (also 10 in skilled trade).
(c) On the job training -- self developed training aids.

(a) Tool and die apprentices when and if it will be approved by UAW.
(b) To date -- none.

(a) Various set up jobs in different departments.
(b) 9.
(c) Visual aids, video tape equipment, OJT of information presented.
(d) Not yet measurable.

(a) For 2 above -- had 10 supervisors job rank priorities for all.
(b) 40
(c) PI -- specific job tests; some evening classroom applied.
(d) Expect five to 10% reduction in maintenance time and costs.

8. Describe briefly the PBT applications you plan or hope to make in the future.

Complete change in apprentice programs.

We are hoping to continue our use of the PBT system in all of the areas of skills training including, vehicle operations and maintenance troubleshooting, and preventive maintenance.

Continue to expand this method of training to all apprentice occupations.

All basic trades apprenticed as time and money permits.

Nearly all of our technical and manual skill training programs.

Reduce scrap charges, better safety and injury record, lower instructional cost/trainee.

Generation Department employees have five different areas in which to advance. Skills are varied coming in. This will allow them to move very quickly through the area they are familiar with.

Expect to make evolutionary changes in other skills training programs as we go.

All machine shop jobs.

Individualize all apprentice and industrial training at Triton.

Specialty Machine Training.

Cutter Engineer.

We will try to have our performance testing requirements in this concept in the apprentice program.

We want to apply PBT applications to at least the following craft areas: electrician, machinist, machine repair, pipefitter.

Apprenticeable trades: tool and die, machine repair, screw machine.

At some time in the future I may propose modifying our existing specialized in house lathe training program to PBT guidelines. This is somewhat dependent on the time available and my supervisor's opinion of any PBT proposal I might bring to him.

We would plan for entry level jobs, i.e., small drill presses, punch presses, sub-assembly operations.

The training of "semi" skilled-skilled personnel. Approximately six other employees have jobs that are somewhat skilled but not classified skilled.

Same.

Individualize machinist, tool and die, machine repair apprentice programs.

9. In general, how satisfied are you with the PBT applications you have made?

I was before I made it but am most satisfied now.

We are very satisfied with the PBT applications so far implemented.

Very satisfied with our methods for training apprentices.

Too early to fully evaluate.

Very!

Fair.

So far -- very satisfied.

Yes.

Too early to make this decision.

Very well satisfied!

100%

We believe that each individual will learn and retain best at his own pace.

Haven't done so yet.

Have not made any.

Have not used it.

So far -- no problems -- our measurement won't occur until the program is finished.

Looks good at this point. Hope to use as pilot project for approximately 200 more maintenance personnel.

The individualized T.V. program works quite well.

10. What are the major problems you have encountered or anticipate encountering in applying PBT?

Changing others, instructors, bosses, etc., into believing this is the way to go.

None.

None.

Assuring that tasks are properly developed to assure performance competency.

1. Resistance to change; and
2. More front end and on course design.

Getting line supervisors to define behavioral objectives. They are used to saying "thats not what I wanted!" after the fact.

Supervisor resistance -- it's not the traditional way. Rewriting most training materials.

Measurement of on-the-job performance in a construction and/or job shop environment.

All programs are now teacher oriented.

Time to develop teaching materials.

Money and program development.

Our employment has been down. As a result we've had little opportunity for training.

UAW supervisors and traditionalism.

Union resistance, cost of material and equipment, and initial (developmental) cost.

The effort required to develop an effective task analysis.

A fairly low turnover rate at present (we've trained only about six persons for this particular job during the last year's time) may make it difficult to justify a modification of our current training program until business begins to pick up somewhat.

Probably the major problem I see concerns performance standards and individual differences. Setting up pre-job performance standards for new employees in the department and applying them uniformly to persons whose previous machine operating experience varies from almost none at all to several years of related experience can prove to be difficult. In our specialized job even the more experienced operators generally do not produce at greater than 50% of time standards after completing our usual five day training period. For that matter, for a period of several weeks or even months afterward many have still not been able to reach the 75-80%

level. Suggestions to management in the past to vary the training time to 6-7 days or longer for a slower employee, have not been favorably accepted. Talk turns quickly to production schedules and short handed crews, a new man is needed on the floor for production, "Right away!", seemingly even if his production is not all that it should be.

During our five day training period most of our time is primarily concerned with getting a rather large amount of information (much of which may not be directly concerned with the actual operation of producing the part) to the employee making sure he knows the procedures involved in the job and the corrections he can make to a part that's slightly out of specifications, as well as the short cuts he can use to save himself time on the job. Only secondarily have we been concerned with production quantities during training. Our philosophy seems to be if he knows how to do it right and knows the usable short cuts in the job, the production rate will soon increase rapidly. Because of these individual differences and our lack of strong emphasis on accuracy and speed, I feel measuring results cannot be efficiently done at the end of our training period.

Does not apply.

The time away from the job to train.

Need full management awareness backing.

Developing curriculum.

11. In what areas, if any, do you feel you need more help in applying PBT?

Proof of its value.

We are gaining experience, however, we would like to hear of any additional seminars, etc. that might become available for our participation.

None.

None at this time. We plan to develop additional PBT programs after 1976 negotiations.

None at this time. Other than talking with others doing same thing.

Defining objectives.

Performing measurement as above. Note: The "value" of any job or group of jobs in shipbuilding is pretty nebulous. Ship is "sold" to owner on a percentage completion basis. We know what a job "costs" but not really what we sell it for.

Doing the actual task analysis.

Development of the actual programs.

Developing performance standards and progress criteria.

None at the present time.

Don't know yet.

Personally still need more information.

Curriculum development and instructional procedures.

13. If you have not applied PBT to any tasks or jobs in an apprenticable or skilled trade, please indicate why not?

I thought a letter in response to your questionnaire would be better than check marks.

First, let me say that I was very much impressed with your training program. I think it could be used with great success in training unskilled new employees.

Unfortunately, as you know, the machine tool industry has suffered a long period with low volume of orders. We have many on lay off that we hope to recall when the orders increase. In the meantime, we have no need to train anyone until our recall list is exhausted. When we start a training again, we will consider your program.

Thanks for your interest.

Company sales down, many skilled people on layoff, lack of funds for training.

Company has policy of conventional classroom instruction.

Needs further study.

We have in the past and will in the future.

Time has not been allowed to do an extensive job analysis.

Still attempting to secure the green light from top management.

Because existing training methods are producing desired results.

Staff required to develop and analyze task specifications.

In a multi-plant organization we have no central staff currently assigned to or responsible for skills training. Excellent work is being done by local staff at some or many plants, but there has been no deliberate or conscious effort to apply PBT techniques.

At present we have only four apprentices who are pretty much left on their own once an outside class schedule has been worked out for each. Because we are not associated with a union, the apprentice training program we have had for only the last two or three years has been set-up to comply with state guidelines for apprentice training which includes time spent on the job as well as time spent in job oriented classes.

Quite frankly -- other priorities have taken precedent.

We are in the process of task identification and curriculum development for the machine trades.

14. If you have not applied PBT to any task or job at all, please tell us why not.

We have applied PBT but with a limited budget.

Management decision.

In house training meets all our needs.

No time and UAW backlash.

We have in a small way in the craft technology classes (teaching the intricacies of the craft), e.g., electric lab.

Staff required to develop and analyze task specifications.

In a multi-plant organization we have no central staff currently assigned to or responsible for skills training. Excellent work is being done by local staff at some or many plants, but there has been no deliberate or conscious effort to apply PBT techniques.

Since the seminar we've primarily been concerned with the completion of current projects rather than the development of new programs. This information has been looked through several times by me, but no serious effort has been made to draw up a basic outline to a PBT program.

Quite frankly -- other priorities have taken precedent.

Not properly prepared to implement at present time.

Joint Workshops
Performance Based Apprentice and Technical Training
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LET'S CONCENTRATE on PERFORMANCE

in

TECHNICAL and APPRENTICE

TRAINING

by
ARTHUR E. ORIEL

This paper is based in part on a full research report prepared for the Manpower Administration, U.S. Department of Labor, under research and development contract No. 82-17-71-48 authorized by Title I of the Manpower Development and Training Act. The contents of this paper do not necessarily represent the Department's official opinion or policy. The author is solely responsible for all opinions and for the factual accuracy of all material included in this paper.

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PERFORMANCE BASED TRAINING

1. Accurate, Detailed, W.itten Task Specifications
2. Behavioral Objectives Grow Out of Task Analysis
3. Measured Achievement of Behavioral Objectives
4. Measurement of Effectiveness Built-in
5. Fully Utilizes Individual Differences in Learning Ability
6. Trainees Progress at Own Best Pace
7. Empirical Procedure-Decisions Based on Trainee Input

MOST CONVENTIONAL TRAINING

1. General Curriculum requirements
2. Course Goals or Objectives. Usually Not Specific Performance Standards
3. Number of Hours of Training
4. Measurement Often Lacking or Subjective
5. Fails to Utilize Individual Differences
6. Trainees Progress at Group Pace
7. Subjective Process-Trainees Have Minimal Voice

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INTRODUCTION

Most managers would agree that training can be justified in a business organization only to the extent that it produces acceptable levels of job competence with acceptable efficiency, i.e., in reasonable learning time and at reasonable cost. Those responsible for technical and apprentice training in industry are rarely given unlimited time in which to produce competent job performance; they are virtually never given unlimited budgets.

To accomplish these objectives one must, first, have reliable measures of job performance. Without such measures it is difficult, if not impossible, to know when trainees have reached the goal, when one may stop training. Further, one must have training methods that minimize both learning time and costs.

For the past decade or so, these characteristics have been most effectively provided by what has been known variously as the "systems approach" to training, educational technology, individualized instruction, and, our own version, called Performance Based Training (PBT).

The essential characteristics which differentiate Performance Based Training from more conventional training programs are set forth in the chart on the facing page. It is clear from the chart that PBT provides reliable measurement of performance; and, because it is task based and utilizes individual differences, it also offers the efficiency that is often lacking in more traditional group-paced approaches.

During the past ten to fifteen years this modern approach to training (Performance Based Training) has won increasing acceptance in both industry and in vocational and technical education. Some part of or variation of the system is in use in most of the large corporations in this country, including IBM AT &T, DuPont, Lockheed, Caterpillar Tractor Company and Ford Motor Company, to name just a few. A considerable number of technical and vocationally oriented colleges are also applying these new methods. For example, at Wanbonsee College in Illinois the entire machine shop and automotive technology courses are now performance based and individually paced. The new "block method" of technical training developed by the Ontario (Canada) Department of Labour represents a sharp departure from traditional training and a step in the direction of Performance Based Training, as does much of the new work in trades training being carried out in England under government sponsorship.

It was an interest in exploring the feasibility of applying these modern training methods to apprentice training that led the author to conduct, in 1966 and 1967, a task analysis of the skilled trades at a large midwest manufacturing company. That study of approximately 2,500 skilled personnel in 22 plants -- at the time

the largest of its kind ever undertaken by private industry -- led to a complete redesign of the company's apprentice training programs. The new programs resulted in a significant reduction in learning time and instructor time and increased flexibility in the training programs.*

It was a similar interest, at least in part, that led the Office of Research and Development, Manpower Administration, U.S. Department of Labor to sponsor, during the past eight years, more than twenty studies of virtually every aspect of apprentice training in this country, including the study report here.

A review of these studies reveals a striking consistency in the findings of the many different investigators with respect to the strengths and weaknesses of existing apprentice programs, in the conclusions they draw and the recommendations they have made.

Here is a brief summary of the major problems of traditional apprenticeship programs that have emerged from these research studies:

1. There has been fairly widespread failure to apply systematically the training standards and procedures that have been developed over the years and are recommended by the Bureau of Apprenticeship and Training and other organizations. Thus, much of the training that is done is not as systematic nor as efficient as it could be.

2. (a) The primary objective of most programs is based on training time rather than demonstrated competent performance, the end product of training that should be of greatest importance to both employer and trainee.

   (b) Objectives have, for the most part, been developed on a rational basis, rather than through up-to-date methods of task analysis.

   (c) Systematic measurement of job performance to establish both journeyman status and movement from one phase of training to the next is infrequently used and is subordinated to the criterion of number of hours on course.

---

* See Appendix A, Improving Performance in Technical and Apprentice Training, by Arthur E. Oriel 1974. Available from National Technical Information Service, U.S. Department of Commerce, Springfield, Va. 22151 (PB 231 - 241) $ 7.50

3. The tests and other methods and criteria used to select and place apprentices are, in most cases, seriously lacking in validity, overweighted with verbal skill requirements and probably discriminatory where minority group members are concerned. Further, validated methods of measuring achievement within a training program are seriously lacking.

4. In many programs there is a serious temporal discontinuity between related instruction and shop instruction.

5. Training methods are most often traditional and little effort has been made to use the newer and more efficient education technology.

6. Journeymen carry most of the burden of apprentice training, despite the fact that the majority of them are not trained instructors and are usually too busy with their own responsibilities to have time to train apprentices efficiently.

7. Apprentices, whose careers are most affected by the training they receive usually have little or no voice in developing the programs in which they will be trained.

It was in the interest of addressing such problems that the study reported here was undertaken.

OBJECTIVES AND METHODOLOGY OF THE STUDY

Objectives

The major objective of the present study was to demonstrate that, through the judicious application of modern training technology, an effective first year apprentice training program could be developed in which performance is the primary criterion of success and training time is allowed to vary with individual capability. The more specific objectives were to:

1. Fully utilize individual difference in learning ability by allowing each trainee to progress at his own pace.

2. Base progress through the course on demonstrated task achievement rather than number of hours on course.

3. Enable apprentices with only modest but appropriate verbal skills to complete the program successfully.

4. Require that all apprentices achieve similar high levels of performance in both shop and related training even though some may take more time than others.

5. Increase the efficiency of training by minimizing the temporal discontinuity that now exists in most programs between shop and related classroom training.

6. Lift some of the burden of the instructional process from the shoulders of journeymen who have neither the time nor the training to be competent instructors. These men can be used to bring their wealth of experience to bear to help trainees refine and polish their performance.

7. Demonstrate that a self-paced, time-variable program results in a significant saving in both learning time and instructor/journeyman time.

Procedures

To achieve these objectives within the constraints of time and budget, it was decided to concentrate on the first year of apprentice training in the metal trades: machinist, tool and die maker, machine repair, those trades that have a common first-year curriculum. The following steps were carried out:

1. Completion of the Task Analysis. Since movement through the PBAT program was to be based on demonstrated task achievement rather than hours on course, the starting point of the system had to be an analysis of the tasks normally required of first-year metal or machine trades apprentices and trainees. Such a task analysis had already been partially completed by the author and his associates in 1967 as part of a project to redesign the apprentice training programs at a large manufacturing company.

   Additional analyses were carried out in selected plants of the companies that were cooperating in the study. This analysis revealed that, in these plants, first year apprentices used a total of 55 tools and measuring instruments and performed an average of 170 major tasks on the shop floor.

   Once this task list had been completed a competent foreman performed each task under our observation. While performing each task, he also recorded on sound tape a complete description of what he was doing and answered questions about the covert non-observable behaviors involved

The result was a complete record of the behaviors involved in the performance of each task and sub-task required of first year apprentices in learning to set up and operate the four basic machine tools: mills, lathes, drills and grinders.

2. Development of Behavioral Objectives. Based on this analysis, a total of 338 behavioral objectives were written to cover the knowledge and skills required to perform competently, both in related instruction and on the shop floor. These behavioral objectives covered all tasks commonly required of a first-year graduate.

3. Development of Performance Tests. Based on the behavioral objectives, a series of 17 paper-and-pencil performance tests was constructed which covered the domain of, and measured the level of achievement of the 185 related instruction objectives. The same tests were used both as pretests to measure the entering behavior of trainees, and as post-tests to measure achievement of the behavioral objectives.

The tests covered the following areas:

1. Identification and Use of Basic Hand Tools
2. Linear Measure and Fractions
3. Micrometer Instruments and Decimals
4. Basic Industrial Mathematics
5. Vernier and Dial Instruments
6. Reading Engineering Drawings
7. Layout
8. Metal Cuttifig Fundamentals and Speeds and Feeds
9. Work Holding Devices -- Slotted Table
10. Milling Cutters
11. Lathe Work Holding Devices
12. Lathe Cutting Tools
13. Twist Drills I
14. Sharpening Twist Drills
15. Threads and Taps
16. Reamers, Countersinks and Counterbores
17. Grinding Wheels

In addition to the related instruction tests, 31 audio-visual shop training modules were developed which functioned both as training modules and as performance tests. Twenty-two of these modules required the trainee to cut metal -- to make a part -- as opposed to the orientation modules which did not. For each of these 22 modules a Training Assignment Sheet was developed which gave the trainee the information he needed to complete the assignment. These sheets also required the trainee to record the end product

of the judgments, decisions, calculations he had to make to complete the assignment (i.e., speeds and feeds, tolerances, depth of rough and finish cuts, etc.). The completed assignment sheet taken together with the workpiece produced -- without the aid of the A/V training module -- constitutes a complete criterion performance test record of what a trainee is capable of doing. If a trainee could pass the test, according to the performance standards set forth in the behavioral objectives, he had achieved the criterion for that set of objectives.

4. Development of the Training Modules. A total of 15 printed self-instructional modules were developed specifically for the project. Two commercially available modules were used for mathematics and reading engineering drawings.

In addition, 31 A/V shop training modules were developed to be used at the machines on the shop floor. These consist of 735 photographic slides (35 mm) and 27 sound tapes. They are used in a Kodak Carousel 35 mm slide projector together with a manually operated cassette tape recorder and headset. The slides are projected on a 14" x 14" portable rear screen device. The entire A/V set-up is mounted on a table or bench and used at the machine on the shop floor.

The complete series consists of the following modules:

Milling Machine

1 - 4.	Introduction to the horizontal milling machine
5.	Introduction to the vertical milling machine
6.	Plain (slab) milling
7.	Side milling a slot
8.	Form milling a radius
9.	Sawing a slot
10.	Face milling
11.	End milling a closed end slot
12.	End milling a pocket

Lathe

13.	Introduction to the engine lathe
14.	Facing
15.	Turning to a shoulder
16.	Taper turning with the compound
17.	Parting and grooving
18.	Chamfering
19.	Drilling and centerdrilling
20.	Boring

21. Reaming
22. Filing and polishing
23. Knurling
24. Taper turning with attachment
25. Cutting threads

Drills

26. Introduction to drills
27. Drilling, counterboring and countersinking
28. Reaming
29. Machine tapping

Surface Grinder

30. Introduction to the surface grinder
31. Truing and squaring

In addition to the audio/visual training modules, Shop Work Assignment Forms were constructed. Once an apprentice had completed the A/V sequence on a particular machine (i.e., the lathe) he was to be given three or four regular work assignments that came through the shop. These would require that he apply the skills he had learned to an actual job. He was required to enter on the form much the same information he had entered on his Training Assignment Form: (1) type of operations to be performed; (2) type of work holding device he used; (3) tolerances; (4) type of cutter to use; (5) number and depth of cuts; (6) speeds and feeds he would use.

His performance on the machine, the quality of the part he produced and the accuracy of his judgments and calculations were rated by an instructor or journeyman and the time it took him to set up and complete the job was recorded together with the amount of journeyman supervision required. The form also asked the journeyman or foreman to estimate how long it would take a competent journeyman to complete the job.

The purpose of this procedure was to test the efficiency with which apprentices could apply to actual jobs coming through the shop what they had learned from the A/V modules. These assignments functioned as criterion tests of the teaching effectiveness of the experimental program.

Later in the study, since we could find no established criteria of what a 2,000 hour apprentice should be able to do, we used these forms to evaluate the performance of the subjects in the comparison group.

Thus, the complete system consisted of:

17 Printed self-instructional related training modules
17 Achievement tests
31 Audio-visual shop training modules
22 Training Assignment Sheets that were also used as shop performance tests
12 Shop work assignments
1 Apprentice master achievement record

All of these materials were tested on trainees as they were developed and were revised whenever trainee performance indicated revision was necessary.

Field Test

The complete system was field tested on 47 first-year apprentices and trainees from Caterpillar Tractor Co., International Harvester, Mercury Marine Engine and an MDTA class from Westinghouse Area Vocational School in Chicago. Each of these 47 trainees, the experimental group, went through the experimental Performance Based Training system on an individualized, self-paced schedule.

The following table summarizes the demographic characteristics of the 46 men and one woman in the experimental group.

EXPERIMENTAL GROUP

	Median	Range
Education (grade)	12	9 - 16
Shop Courses Taken	1	0 - 6
Math Courses Taken	2	1 - 6
Reading Achievement*	10.1	5.6 - 13.6
Arithmetic Achievement*	10.8	6.5 - 14.8

* The tests used for these measures were the Surveys of Reading and Arithmetic Achievement, Junior High Edition, published by California Test Bureau.

The performance of the experimental group was compared to a second group of 40 trainees, from two large midwest manufacturing companies, who had completed the equivalent of the first year of conventional related instruction in a metal trades apprentice program, and some portion of their shop training.

The group of 40 consisted of 4 black and 36 white apprentices 39 men and one woman. The median educational level of this group was twelfth grade and, except for the amount of training they had, there were no significant differences in background between the comparison and the experimental groups. The group consisted of machinist, die maker, toolmaker and machine repair apprentices in both two year and four year training programs. At the time they were tested, this group had completed an average of 187 hours of related instruction and 1177 hours of shop training.

Although the group had completed more than 144 hours of related instruction (the conventional first year requirement) and more than half of their required 2000 hours of shop training, there were serious problems in comparing their performance to that of the experimental group.

Although most of the group had covered the elementary first year subjects, very few had taken courses in geometry or trigonometry, layout, mills or grinders. And less than half had received shop training on mills, lathe and grinders. These data point clearly to the lack of uniform training requirements and make it difficult to compare the performance of the two methods of training.

RESULTS OF THE STUDY

In view of the major objectives of the project, the most significant results to emerge involve the quality of performance attained by the experimental group and the time required compared to established apprenticeship requirements. The times required for the experimental group to complete the entire first year curriculum are presented below.

	TIME IN HOURS		
	Slowest Trainee	Mean	Fastest Trainee
Related Instruction*	107:00	61:52	24:12
A/V Shop Instruction	57:12	39:30	29:42
Total	164:12	101:32	53:54

* Figures include times to complete pretests, training modules and post-tests.

On the average, apprentices in the experimental group completed, in 101 hours and 32 minutes, the entire first year of related instruction (in technical subjects required for job performance only), plus basic training in all the tasks he would be required to perform during his first year on the four basic machine tools.

Related Instruction

The 61 hours and 52 minutes on the average needed for related instruction can be compared to the 144 hours of related instruction usually required of first year apprentices. In fact, the coverage of the experimental curriculum was broader than that usually received by first year apprentices. As already pointed out, a considerable number of the comparison group trainees did not cover, in their first year, the full range of subjects included in the experimental curriculum.

Even the slowest trainee completed the course in considerably less than the standard 144 hours. The faster apprentices were able to finish in such startlingly short time because several who had previous training were able to score 90 percent on a number of pretests and thus, were not required to complete those training modules.

The longer times were due to the fact that some trainees learn at a slower pace and also to the recommended practice -- followed in at least one company -- of requiring trainees who did not score 90 percent or better on the post-test for any module to go back, review the module and retake the test.

The figures leave little doubt that the learning time required to achieve an acceptable level of performance in related instruction can be considerably less than the 144 hours that is now standard. It may be useful to distinguish between "learning time" and "exposure time", a distinction made by Hardman and Munn in their study of apprentice training. * The 62 hours required by the experimental group may be thought of as "learning time", while the standard 144 hours may be considered "exposure time". If learning curves, and thus learning time, can be accelerated, then increased productivity, efficiency and flexibility are the logical results.

---

* Hardman, W. and N. Munn, A Study of Accelerated On-The-Job Training Program for the First Year of On-The-Job Training for the Precision Machinist Apprentice, National Tool, Die and Precision Machining Association, 1973.

The performance of the two groups in related instruction are compared in the table below.

RELATED INSTRUCTION PERFORMANCE
OF EXPERIMENTAL AND COMPARISON GROUPS

	Experimental Group	Comparison Group
N	47	40
Mean	85.7%	59.6%
Range	53.0 - 97.6%	28.4 - 80.7%
s.d.	11.9	10.7
t	10.6	
p	.01	

The overall mean achievement score of the experimental group was significantly greater than that of the comparison group. But, the former had taken the performance tests immediately following training in each module, while the comparison subjects had taken the test from three to nine months following training in some courses.

To determine the effect of this time lag two groups of 19 experimental trainees were given the test from three to nine months following the completion of their training. This group had a mean of 750 total hours on course and 185 hours of related instruction. The results of this comparison are as follows.

COMPARISON OF MTAE SCORES
OF EXPERIMENTAL AND COMPARISON GROUPS

	Experimental Group	Comparison Group
N	19	40
Mean	77.2%	59.6%
Range	55.8 - 90.0%	28.4 - 80.7%
s.d.	9.9	10.7
t	6.05	
p	.01	

Despite the time lag, the experimental group outperformed the comparison group to a significant degree, and with a mean achievement score only 10 percent below that achieved (85. 7 percent) immediately after the group completed training. The experimental program not only produces high levels of performance in related instruction, the knowledge and skills developed are relatively resistant to deterioration, at least over this short time.

One further check was run to determine whether comparison group scores vary with number of hours of related instruction completed. The rank-order correlation between these two variables is . 06 (not significant). There appears to be little, if any relationship between achievement and time spent, at least within the range of hours completed by this group (66 to 304). This result, although based on a small number of cases (40), is consistent with the findings of Hardman and Munn and of Rigby and Eiffert. It is axiomatic and perhaps redundant to reiterate that the quality of what takes place during each hour of training, rather than number of hours, is the critical variable in determining level of post-training performance.

It is this single, obvious fact that argues most eloquently for training programs in which performance outcome is the primary criterion and time is allowed to vary. In virtually every study of self-paced training reported in the literature, the average "learning time" is significantly lower than the total time required in comparable conventional, fixed-time courses.

Concentration on fixed-time as the primary criterion may often lead to a preoccupation with number of hours rather than what happens during and more important, after those hours of training.

Shop Training

One of the most difficult problems in evaluating the shop performance of the experimental group is the absence of a criterion against which to measure it. As already indicated, no specific behavioral standards of shop performance could be found for 2, 000 hour metal trades apprentices. Number of hours completed is the primary standard in common use. And, as Hardman and Munn have indicated, there is wide variation in how apprentices spend those 2, 000 hours and what they are able to do at the completion of them.

It was also impossible to use the performance of comparison subjects at the end of 2, 000 hours, since the machine time and trainee time required to administer the shop performance tests could not be made available on the schedule needed. One alternative available was to get from the foremen who supervised the comparison

subjects ratings of how well their apprentices would perform on the 14 of the shop performance tests that were taken by the experimental group during the course of their A/V shop training. The ratings were made on a four point scale from excellent (4) to unsatisfactory (1). The results of this analysis are presented below.

FOREMEN'S RATINGS OF APPRENTICE SHOP PERFORMANCE

	Comparison Group	Experimental Group
N	40	47
Average Number of Hours of Shop Training	1177	39.30
Range	338 - 2300	29-57
Mean Rating of Quality of Work	3.1	3.8
Dm	.7	
t	3.88	
p	.01	

Despite the great difference in number of hours of shop training, the performance of the experimental group was judged by foremen to be of better quality than that of comparison subjects who had thirty times the amount of shop training.

There are probably a couple of factors that help to explain these results. First, the experimental group received intensive and systematic training -- using the A/V shop training programs -- in the performance of all the basic machining tasks on all four of the basic machine tools: mills, lathe, drills and surface grinder. The comparison subjects received their training on these machines through the conventional method of being given shop assignments haphazardly as they came through the shop. Unless training assignments are scheduled in such a way that what an apprentice is doing today reinforces what he partially learned yesterday, or if too much time elapses between similar assignments, reinforcement is lost and the result is inefficient training and poor performance. This is what research has indicated happens in many conventional apprentice

training programs. The use of the A/V shop training modules mitigated this problem to a great extent through carefully designed sequences of machine training that produce optimum reinforcement -- provided, of course, they are used properly.

Second, the 39½ hours of shop training received by the experimental group probably represents what Hardman and Munn called "learning time". The 1,177 hours of shop training received by the comparison subjects is probably comparable to what they called "exposure time". Our results tend to support their conclusions. It appears that further exposure, beyond the time required to learn, leads to little further learning when the same or similar tasks are being performed. This point is valid of course only when the initial learning time is used efficiently.

Additional exposure beyond that required to lear[illegible]ay lead to further performance development, however, if the ini[illegible]ing time has not been efficiently used. This can be seen by comp[illegible] the work quality ratings of comparison subjects with different exposure times. The average rating of comparison subjects with less than 1,300 hours on course was 2.9, while th[illegible] of subjects with more than 1,300 hours was 3.4. Although this difference is not significant, it is in the right direction and may indicate that some learning -- albeit very inefficient -- continues to take place with continued exposure.

Another attempt to evaluate the performance of the experimental group involved the time to complete the Shop Work Assignments completed by trainees in this group immediately following the completion of their A/V training sequences. (See APPENDIX F) In order to establish an estimated standard of performance of 2,000 hour apprentices based on actual work assignments, foremen were asked to estimate how long it would take an average 2,000 hour apprentice to complete each of nine work assignments on milling machines and lathes and to rate the quality of expected performance. These assignments were among those actually performed by experimental group trainees after an average of 39½ hours of training. Thus, we had actual times and quality ratings on the experimental group. We also had estimates -- gathered from another group of foremen -- on how long it would take a competent journeyman to complete each assignment. The results of this analysis are as follows:

ESTIMATED AND ACTUAL MEAN TIMES TO COMPLETE SHOP ASSIGNMENTS

	Estimate - 2000 Hour Apprentices	Estimate - Competent Journeyman	Actual Experimental Group
Total Hours to Complete 9 Assignments	86	52	119
Mean Hours per Assignment	9.5	5.8	13.2
Mean Differences	3.7	3.7	

Thus, after 40 hours of training the experimental group completed these nine assignments in 119 hours. The foremen estimated that an average 2,000 hour apprentice would take 86 hours to complete them -- 28 percent less than the experimental group. The additional 1,961 hours of shop training leads to only a 28 percent improvement in estimated performance time. The question must be raised whether a 28 percent improvement could not be achieved in significantly fewer training hours through more systematic shop training procedures. The critical distinction again is that between "learning time" and simply "exposure time".

These results are also consistent with those that emerged from the author's study of 1967. The number of hours estimated by journeymen and foremen to be required for apprentices to achieve mastery of the four basic machine tools was more than 50 percent less than that recommended by established apprenticeship time standards.

In view of our objective to lift some of the burden of shop instruction from the shoulders of journeymen, one important result involves the amount of shop instructor time required by the PBAT audio-visual shop training programs. Shop instructors spent an average of only three hours per trainee in taking apprentices through their average 39½ hours of basic machine tool training. This is in striking contrast to the amount of journeyman time normally thought to be required in conventional apprentice training programs.

The results of this study, and many others that utilized modern training technology indicate clearly that the judicious application of Performance Based Training methods can result in better job performance in shorter learning time, greater flexibility and reduced training costs.

The reader who wishes to examine the complete report of the study described briefly in this paper may purchase a copy from National Technical Information Service, Springfield, Va. 22151.

Order: PB - 231 241 "Improving Performance in Technical and Apprentice Training." March 1974 $7.50

PERFORMANCE BASED TRAINING

ANNOTATED BIBLIOGRAPHY

This bibliography presents a cross section of papers, articles and books that describe research on apprentice training; the nature, process and effectiveness of modern training technology; task analysis, performance analysis and performance testing. Taken together, the articles represent a reasonably complete, but not necessarily exhaustive, picture of how the performance systems approach to training has revolutionized industrial training over the past 15 years. They also present indisputable documentation of the efficiency and effectiveness of modern training methods.

The bibliography is arranged by general subject, rather than alphabetically by author. The subjects covered are:

I Apprentice & Technical Training
II Performance and Task Analysis
III Establishing Behavioral Objectives
IV Case Histories of the Effectiveness of Performance Based Training Systems
V Program Development
VI Cost Effectiveness
VII Performance Testing

In each section articles and books of significant importance are described briefly. This is followed by a listing of other articles and books which are either of lesser significance or for which descriptions are not available.

An overview of the entire list and the philosophy that permeates it can be seen from a reading of the following:

Januszewski, C. S., A Time Capsule.. Industrial Training 1974: Retrospection from the Year 2024, Training and Development Journal Vol. 28, No. 6, June 1974.

A somewhat fanciful article that describes the major trends in training in 1974 from the viewpoint of a time capsule opened in 2024.

The emphasis in the description of 1974 training is on self-paced, individualized training, performance analysis, cost/benefit analysis, the instructor as administrator/counselor rather than lecturer and on measuring results.

A brief description of one man's view of training trends over the next 50 years from the vantage point of a large corporation -- Westinghouse Electric Company.

Committee On Education and Labor, House of Representatives, To Improve Learning, A Report to the President and the Congress of the United States by the Commission On Instructional Technology, Washington, D.C., March 1970.

I. APPRENTICE & TECHNICAL TRAINING

Rigby, Lynn V. and Arthur R. Eiffert, Time Utilization in Apprenticeship Programs, Sandia Laboratories, Albuquerque, N. M., 1971.

A survey of 137 apprentice graduates in seven different trades in three different companies was carried out to learn graduates' attitudes toward the length and effectiveness of their apprentice training.

Forty eight percent of new apprentice graduates and thirty percent of all graduates thought their training was too long and could be reduced by 15% or more. Great variability was found from company to company and trade to trade in coverage and effectiveness of apprentice training.

As with most research on apprentice training, the study resulted in these recommendations:

1. Efforts should be spent on standardizing rather than reducing time spent in apprenticeship.
2. Total time should not be changed until it is clear it would have no detrimental effect on competence.
3. More serious thought and effort should be given to the need for uniform performance measurement to evaluate competence.

Bergevin, Paul, Industrial Apprenticeship, McGraw-Hill Book Co., Inc., New York, 1947.

Dempsey, Marion, A Twentieth Century Concept, The Canadian Personnel and Industrial Relations Journal, November 1970.

Industrial Training Branch, Ontario Department of Labour, Occupational Training -- A New Approach, Toronto.

Industrial Training Branch, Ontario Department of Labour, Report of a Study of the Mechanical Component of the Construction Industry, Toronto, Ontario, 1971.

Kursh, Harry, Apprenticeship in America, W. W. Norton and Co., Inc., New York, 1965.

National Machine Tool Builders Association, Manual of Recommended Training Practices, 4th ed., Washington, D. C., 1967.

National Tool and Die and Precision Machining Association, First Year Apprentice Training Program, Washington, D. C., 1965.

Patterson, W. F. and M. H. Hedges, Educating for Industry, Prentice Hall, Inc., New York, 1946.

Warren, R. M., A New Concept in Industrial Training, Address by Executive Director, Manpower Services Division, Ontario Department of Labour, Toronto, Ontario, May 28, 1968.

Publications of the Office of Manpower Research and Development, U. S. Department of Labor

Marshall, F. Ray and Vernon M. Briggs, Jr., Negro Participation in Apprenticeship Programs, University of Texas, 1966.

The book The Negro and Apprenticeship which received national prominence was based on this research. The researchers recommended expansion of pre-apprenticeship programs to increase the supply of qualified Negroes entering apprenticeship. This approach to increasing the numbers of blacks in apprenticeship positions was adopted by the Department of Labor and resulted in the establishment of pre-apprenticeship programs throughout the Nation.

Drew, Alfred S., Educational and Training Adjustments in Selected Apprenticeable Trades, Purdue University, 1969.

A comprehensive examination of apprenticeship program administration, policy-making, selection and recruitment, and the training process was conducted in the pipe, machine tool, printer-compositor, and cook-culinarian trades. Suggestions are offered for developing an optimum apprenticeship system, and

journeyman training to prevent obsolescence of skills. A 5-volume monograph has been prepared (Manpower Research Monograph No. 20, Toward the Ideal Journeyman) based on this study.

Horowitz, Morris A. and Irwin L. Herrnstadt, The Training of Tool and Die Makers. Northeastern University, 1969.

The study was designed to determine the kinds of education, training, and experience that were most likely to produce highly qualified tool and die makers. It was conducted in manufacturing firms in the Boston area. The researchers found that there were no important differences in the competency of the tool and die makers produced by various training paths. It was not so much the training but the aptitudes and interests of the person that seemed to account for competency.

Somers, Gerald, A Conference on Research in Apprenticeship Training, University of Wisconsin, 1967.

A conference was held September 1966 to stimulate research into problems of contemporary apprenticeship programs and to encourage broader dissemination of pertinent research findings. Among the topics discussed were: the problems of related instruction, the role of joint apprenticeship advisory committees, the use of pre-apprenticeship training, and the experience of minority groups in apprenticeship.

Ebel, Karl H., Sven Grabe, Jacques Monat, and Angela Butler, European Apprenticeship (ILO CIRF Monograph, Vol. 1, No. 2), International Labour Organization, 1966.

The researchers found that while basic administrative patterns of apprenticeship in Western Europe have remained traditional, the purpose of such training is evolving into a system of work-oriented education for out-of-school youth. The strongest pressures for change are considered likely to come from accelerated technical development and the current education explosion.

Project Build: A Manpower Demonstration Program, Greater Washington Central Labor Council (AFL-CIO), 1970.

The objective of Project Build was the development and operation of a work-experienced apprenticeship-preparation program to enable inner city youth to qualify and perform effectively in apprenticeship programs, and the design of a skill refinement program for adults who lacked training necessary to attain journeyman status. The project was one of the first pre-apprenticeship programs designed with union support.

Rajan, G. Soundara, A Study of the Registered Apprenticeship Program in Wisconsin, University of Wisconsin, 1967.

This project was a pull together and analysis of a wealth of detail culled from the apprenticeship program's history, records, and files, supplemented by surveys of the participants themselves. The result is the first comprehensive account of any registered apprenticeship program.

Strauss, George, Apprenticeship Problems and Policies, National Manpower Policy Task Force, 1967.

Strauss discusses optimum size and length of apprenticeship based on his earlier field work conducted in New York and California. He concludes that throughout recent history only a minority of skilled craftsmen have learned their craft through apprenticeship and that industry practices seem to have adjusted to this. Strauss suggests that while some expansion in apprenticeship seems desirable, it is not necessary that every craftsman receive his training in this fashion.

Roberts, Markely, Pre-Apprenticeship Training For Disadvantaged Youth: A Cost Benefit Study of Training by Project Build in Washington, D. C., American University, 1970.

This study considered whether a pre-apprenticeship training program, Project Build, to prepare disadvantaged inner-city youth for entry into building trades was an effective investment in "underdeveloped" human resources. The analysis showed a relatively high, fast, economic payoff from the training of these youth. Project Build graduates reduced their annual post-training unemployment more than 10 percent and increased their post-training average hourly earnings by about 60 percent.

Foster, Howard G., Labor Supply in the Construction Industry: A Case Study of Upstate New York, Cornell University, 1969.

The study analyzed the need each year to expand the labor force dramatically within a period of months, and the ongoing need to replace manpower losses and to provide for the secular expansion of labor supply over a period of years. Foster found that apprenticeship had fulfilled its function -- supplying the industry with a key group of workers with a broad knowledge of their trades -- better than previous studies had suggested.

Crabtree, James S., The Structure of Related Instruction in Wisconsin Apprenticeship Programs, University of Wisconsin, 1967.

The investigator examined related classroom instruction offered to apprentices from 1960 to 1966. Crabtree suggested that schools' enrollment policies be altered to a semester or quarter basis of entry so that more flexible and effective instruction techniques might be offered. He also recommended that standardized core curriculums be established for all trade programs in Wisconsin.

Rosenthal, Neal H., Pilot Survey of Training In Industry, Bureau of Labor Statistics, 1973.

The survey determined that it is feasible to collect information on apprenticeship and other types of industrial training from employers by way of a mail questionnaire. Conducted in metalworking industries and public utilities, this investigation sought data on enrollments and completions of occupational training designed to provide workers with skills to enter an occupation, or to upgrade the skills of individuals already employed in an occupation.

Somers, Gerald, Innovations In Apprentice: The Feasibility of Establishing Demonstration Centers for Apprenticeship and Other Industrial Training, University of Wisconsin, 1972.

This survey was conducted to determine whether it is feasible to test innovative and experimental projects through the establishment of a demonstration center for apprenticeship and skill training. Respondents generally favored the idea of federally-sponsored centers that could explore innovations in the administration, funding, related instruction, and on-the-job training aspects of apprenticeship.

Shapiro, Theresa R., and Norman Roussell, Negro Construction Craftsmen in a Southern Labor Market, Louisiana State University, 1972.

This study sought information on both the operation of apprenticeship outreach programs in metropolitan New Orleans and the experience of black construction craftsmen in the southern city. The study found that the young men placed in predominantly white trades stuck with them; their retention rate was much higher than for all BAT indentures. The remaining part of the study, in comparing white and black carpenters, found no significant differences in skills between the groups, whether skill is measured by reports of what kind of carpentry work the craftsmen engaged in most frequently, or in subjective evaluations.

Northrup, Herbert R., and Richard Rowan, Opening the Skilled Construction Trades to Blacks: A Study of the Washington and Indianapolis Plans for Minority Employment, Wharton School of Finance and Commerce, University of Pennsylvania, 1972.

The study examined one plan imposed by the Department of Labor and one developed voluntarily by a community to increase the numbers of skilled minority group members in the construction industry. Blacks have gained an increasing number of construction man-hours in Washington and the absolute numbers of blacks entering the building trades in Indianapolis has increased consistently under the respective plans.

Roomkin, Myron, Improving Apprenticeship Administrative-Funding Arrangements Based on Employer Reactions to Foreign Practices, University of Chicago, 1973.

This study reviewed information on the character and consequence of foreign apprenticeship practices and identified those that appeared replicable in this country. To determine the feasibility of selected foreign inspired innovations, unions' and employers' reactions were collected and assessed in the Chicago SMSA. Generally, both employers and unions are found to be interested in methods to improve apprentice training, but some of the proposed changes are more acceptable to the parties than others. The investigator recommends the establishment of an experimental apprentice wage subsidy program and the expansion of technical assistance to program operators.

Derryck, Dennis, Improving the Retention Rate of Indentured Apprentices Placed By Apprenticeship Outreach Programs, Brandeis University, 1973.

The study examined both the needs of indentured apprentices and the institutional arrangements that facilitate the retention of apprentices currently being placed by outreach programs in four cities. The study found that among the reasons minority apprentices drop out, three predominate: discrimination because of race; customs and traditions of the industry; and on-the-job problems that are unique to the construction industry, such as, constant shifting of job sites and supervisors. The researcher recommends greater emphasis on retention through the strengthening of outreach organizations so they can become more effective advocates for minority apprentices once they are indentured.

Foltman, Dr. Felician, Conference on Apprenticeship, New York State School of Industrial and Labor Relations, Cornell University, 1974.

A $2\frac{1}{2}$ day conference on apprenticeship was held from May 30 - June 1, 1973, in the Washington, D.C. area to present findings from research development projects funded by the MA's Office of Manpower Research and Development, and to discuss the implications of these studies for making changes to improve the apprenticeship system. Foltman recommended inclusion of a broader range of occupations and industries in the apprenticeship system; increase in the amount of financial support for outreach and retraining programs; and incorporation of more performance tests throughout the training process.

Mapp, Patricia, Women in Apprenticeship -- Why Not?, State of Wisconsin Department of Industry, Labor and Human Relations, Division of Apprenticeship and Training, 1973.

This Wisconsin based project sought approaches that would increase the number of women apprentices in the skilled trades and would combat discrimination against women in apprenticeship. The project demonstrated the ability of women to enter a broader number of apprenticeable occupations than previously. At the beginning of the study, women were in 10 apprenticeable occupations with a heavy concentration in cosmetology. When the project ended three years later, women were in 50 occupations. Apprenticeship outreach programs for women have been set up by the Department of Labor in several cities in response to project recommendations.

Oriel, Arthur E., Improving Performance in Technical and Apprentice Training, Development Systems Corp., 1974, NTSI Springfield, Virginia 22151

The project demonstrated the value of emphasizing performance rather than the number of hours on course, of permitting each trainee to progress at his own pace as determined by his individual ability, and of developing specific measurable job performance criteria as primary standards of success in apprentice training programs. In the project, an experimental group of apprentices, instructed under a performance based system of training and programmed modular materials, was able to complete the related instruction course for first year apprentices of metal trades crafts and to master four basic machine tools in far shorter time than a comparison group of apprentices undergoing conventional training.

Barocci, Thomas A., The Dropout and the Wisconsin Apprenticeship Program: A Descriptive and Econometric Analysis, University of Wisconsin, 1972.

This doctoral study surveyed a sample of individuals who completed or dropped out of the Wisconsin apprenticeship program between 1965 and 1970. The survey found that almost half of the individuals who dropped out of apprentice programs did so because either the employer was not fair or the pay was too low. Another 17 percent indicated that they just changed their minds about wanting to work in the apprentice position, and 15 percent quit to take a job as good as the one they could have obtained had they completed the indenture. The study also found that 46 percent of the dropouts who were employed were working in the same general field in which they had been apprentices.

Hardman, William and Norton Munn, A Study of Accelerated On-The-Job-Training Program For The First Year of On-The-Job Training for the Precision Machinist Apprentice, National Tool, Die & Precision Machining Association, 1973.

An accelerated and self-paced instruction program for first year apprentices in the machinist trade was tested on experimental and control groups in different geographic locations. Experimental subjects needed an average of 10.5 hours to learn and perform tasks on the 4 basic machines, while the time required for the comparison group was 34 hours. The investigators concluded that the program for first year apprentices can be reduced to but 35 percent of that recommended by current learning time standards.

Horowitz, Morris, The Role of Related Instruction in Apprenticeship Training, Northeastern University, 1973.

This study assessed the role of related instruction in the training of apprentices in 3 Boston area trades -- machinist, electrician, and operating engineer. The investigators found that the primary goal of related instruction was the acquisition of knowledge and skill for the sake of breadth and flexibility. Other objectives of related instruction include: providing the background necessary for promotion; substituting for on-the-job training which is difficult or expensive to provide, and contributing to the apprentice's acceptability by his peers as a competent craftsman.

Franklin, William, Ray Marshall and Robert Glover, A Comparison of Union Construction Workers Who Have Achieved Journeyman Status Through Apprenticeship and Other Means, University of Texas, 1974.

This study assessed the influences of apprenticeship on the employment and earnings of selected construction craftsmen and described the methods used by non-apprentice trained journeymen to learn their trades and enter the unions. The investigators found that a large majority of the non-apprentice trained journeymen acquired their skills by working as laborers or helpers or by working on the job in open shops. The apprentice graduates tended to work more and suffer less from unemployment than the non-apprentice trained journeymen.

Ongoing Studies

Franklin, William, An Evaluation of Journeyman Upgrading Programs in Selected Construction Trades, Florida International University, Report Due March 15, 1975.

This project is designed to study programs implemented by several building trade unions to train, retrain and otherwise upgrade the skills of their own journeymen members. Five basic trades will be surveyed in both Miami and Washington, D.C. to determine the types of training offered, the frequency of course offerings, teaching techniques, and extent of employer participation and support.

Hammond, Reese, Dual Enrollment as an Operating Engineers Apprentice and an Associate of Science in Engineering. National Joint Apprenticeship and Training Committee for Operating Engineers, Report Due October 15, 1975.

The feasibility of combining apprentice training with junior college instruction is being explored in this 3-year pilot project. At the end of the project's first phase, eight programs, enrolling 550 participants, were in operation. These dual enrollment programs furnish each participating volunteer apprentice with options for career and avocational opportunities and development. First, the program enhances the apprentice's chances for promotion within the industry. Later, at some future point, should the enrollee wish to change careers, his accredited Associate in Science Degree will be applicable to a higher degree. At any rate, it is thought that a better all-round operating engineer is likely to result from the dual enrollment program.

Bullock, Donald, Pilot Study of the Apprenticeship System, Olympus Research Corp., Report Due January 31, 1975.

A pilot study is being conducted in two states to determine the feasibility of a nation-wide survey of the nation's apprenticeship system. Data will be collected on administrative aspects of apprenticeship including costs of training, methods of training, and recruitment and selection techniques to furnish guidelines for improving the apprenticeship system. Data on the employment experience of newly indentured apprentices, apprentices who have become journeymen, and dropouts from apprenticeship will also be collected.

II. PERFORMANCE AND TASK ANALYSIS

Harless, J.H., "An Analysis of Front-End Analysis", Improving Human Performance: A Research Quarterly, NSPI, Washington, D.C., 1973, 4, 229-244.

The goals and procedures of performance analysis (here called front-end analysis) are described and a number of examples are cited. "A proposed $150,000 safety training program was cancelled when performance analysis showed that lack of skills and knowledge were not the most likely cause of the accidents. Instead, a much smaller amount was spent teaching supervisors to recognize error signals that could lead to accidents."

Mager, Robert F. and Peter Pipe, Analyzing Performance Problems, Fearon Publishers, Belmont, California, 1970.

This is a step-by-step guide to figuring out what is wrong in your department or business -- when people aren't doing their jobs right. It considers people who don't know how to do their jobs, so-called "morale" problems, work-flow difficulties, and so on, in a logical manner. The result of carrying problem analysis through this book is a complete diagnosis and description of the nature and source of the problem and a guide for solving it completely, rather than just half-way. 107 pages.

Young, Samuel L., "A Program for Making Clerical Time Count", Management Review, October, 1971, p. 10.

This article is on objective work measurement as done in the Operations Achievement Program at Sundstrand Corporation. OAP is a task force aimed at early diagnosis of performance problems -- detecting the small problems in the way people do their jobs before they turn into major problems which cost a lot of time and money and manpower to correct.

OAP does random sampling; it studies the group and the job, rather than the individual; it considers the mental content of the job, worker traditions, and costing. It is not seen or used as a disciplinary or spying tool -- its function is to analyze and solve problems before they get out of hand, and this article spends a good percentage of its time in explaining how it all happens.

Sisson, Gary R., Development of Training for a New Manufacturing Process, Training and Development Journal, December 1972.

A detailed and excellent article on the design of a training system to develop the human performance required to successfully carry out the start-up of a new manufacturing process. The article is a good example of how the new educational technology can be applied profitably without the use of self-instructional materials and while retaining conventional classroom instruction.

Considerable benefit can be gained simply through the application of task analysis and the systems approach to manpower development.

Miller, R.B., Task analysis: sources and futures, Improving Human Performance: A Research Quarterly, 1973, 2, 5 - 26.

The birth, growth, adolescence, and future of task analysis is described. Developmental problems occurred as the original creative concept was converted into a procedural format. However, the concept of task analysis remains at the center of the ideal personnel subsystem with the potential for integrating different fields such as human engineering, training, selection, evaluation, and management. The opportunities and needs of the future will emphasize new areas such as the analysis of higher order skills, cognitive tasks, task strategies, decision making under uncertainty, and motivation.

Although this article is slightly technical, it is useful for an understanding of the nature of task analysis.

Smith, M.E., Collecting and analyzing critical incidents, Improving Human Performance: A Research Quarterly, 1973, 2, 41 - 50.

A critical incident is a work assignment carried out very effectively or very ineffectively. Critical incident reports are one way of studying job requirements. Suggestions are offered for collecting and analyzing critical incident reports. Suggestions are illustrated with examples from projects.

Folley, J. P., Job task analysis for ascertaining precise objectives for maintenance instructions and related training, Improving Human Performance: A Research Quarterly, 1973, 2, 27 - 40.

This paper presents a formal structure for task analysis to be used as the bases for determining precise objectives and content of initial job training as well as for instructions for tasks of maintenance jobs. These job instructions are called Job Performance Aids (JPAs). The task analysis process includes both task identification and the analysis of identified tasks. A task identification scheme based primarily on hardware analysis is presented as most appropriate for maintenance jobs. A scheme for analyzing the identified maintenance tasks for JPAs and the questions to be answered by an analysis of tasks for training are presented and discussed.

Short, J., A case study of a task analysis, Improving Human Performance: A Research Quarterly, 1973, 2, 56 - 62.

Gilbreth's early work is described to illustrate the continuing objectives of task analysis today. These objectives are to discover (1) what people do or need to do in a particular type of situation, and (2) how they could do it better. An industrial case study is described in which a task analysis saved a company over $2,000,000 per year in training costs. In the past, task analysis has often been used only to make work more efficient. But the challenge of the future is to use task analysis to improve the quality of life at work.

Martin, M. C. and D. E. Brodt, "Task Analysis for Training and Curriculum Design", Improving Human Performance: A Research Quarterly, 1973, 2, 113 - 120.

This is a description of how one group went about the process of conducting a complete task analysis of the job of naval hospital corpsman. Although the method described is not the only one available, the article is clearly written and covers the essential steps in task analysis: task inventory, establishing task priorities, classifying tasks, developing behavioral objectives, performance tests and training sequences. This is a useful article for anyone who is seriously interested in implementing the new training technology.

Huffman, Harry, "A Model for Generating Performance Goals", American Vocational Journal, April 1973, p. 26.

This article works out a simple, straightforward eight-step formula for analyzing any job and working out job performance goals. The procedure adapts equally well for newly hired employees learning new jobs and for established employees learning new machines and/or procedures, and it is a relatively easy matter to build appropriate training on top of such analysis and goal setting.

Farina, Alfred J., Jr., Development of a Taxonomy of Human Performance: A Review of Descriptive Schemes for Human Task Behavior, Technical Report 2 American Institute for Research, Washington, D. C., 1969.

Folley, J. D., Jr., Development of an Improved Method of Task Analysis and Beginnings of a Theory of Training, Port Washington, N. Y., USNTDC, 1964a.

Folley, J. D., Jr., Guidelines for Task Analysis, Port Washington, N. Y., USNTDC, 1964b.

Gagne, R. M., The Conditions of Learning, Holt, Rinehart and Winston, Inc., New York, 1965.

Miller, R. B., Task Description and Analysis in R. M. Gagne (Ed.), Psychological Principles in System Development, Holt, Rinehart and Winston, Inc., New York, 1963.

National Society for Programmed Instruction, "Improving Human Performance Special Issue on Task Analysis", Vol. 2, No. 1, Spring, 1973.

III. ESTABLISHING BEHAVIORAL OBJECTIVES

Mager, Robert F., Preparing Instructional Objectives, Fearon Publishers, Belmont, California, 1962.

This is basic to the whole training/instructional business -- defining what you are trying to accomplish with your training, and what your criteria are for success (i.e., how you are going to recognize successful performance in the trainee and how you will test it). Mager is very clear and concise and, as always, highly readable. 75 pages.

Mager, Robert F., Goal Analysis, Fearon Publishers, Belmont, California, 1972.

A highly readable guide to analyzing goals -- not for mental exercies, but for the purpose of understanding and solving problems, of making sure that what you are dealing with is the problem and not merely a symptom. Sections of the book are Why to Do It, When to Do It, How to Do It, Variations and Consequences, and a final Summary. 132 pages.

Harmon, Paul, "Developing Performance Objectives in Job Training Programs", Educational Technology, November 30, 1968, p. 11.

This article is on the effort of Cybern Education, Xerox Education Division, the Washington D.C. Job Corps Headquarters, and personnel of the Men's Urban Job Corps Centers to put the entire vocational, social skills, and basic education programs into terms of performance objectives. That is to say, "upon finishing program XYZ, the participant will be able to do thus-and-so." Objectives must be measurable and real, rather than undefined and abstract. What follows from that is, that if something in the program isn't useful for reaching one of these performance goals, out it goes.

The article is interesting primarily as a report of their method of developing and writing performance objectives, and in the discussion of their testing. No final result statistics are provided.

Magdarz, Edward F., "Attitude Change via Curriculum in Industrial Education", Educational Technology, September, 1969, Training Technology Supplement Page S1.

This is a proposal for including attitude change in with regular skills and knowledge training, as a measurable, testable thing. The basis for it all is the idea that if you can say what a person looks like or does when he is in a particular state of mind, you can plan training for it, measure it, and test it. For example, you might decide that good attitude toward handling the phone by your receptionist meant that she said "Good morning (or afternoon), Mr. Smith's office", and didn't lose messages. You can train her in that, you can test and measure it -- it becomes part of the concrete, quantified goals that you want to accomplish with the training you give.

The article illustrates its point by means of working out attitudinal goals along with skill/knowledge goals in training for the spark plug part of an auto tune-up job. The article is a bit thick with jargon, but its treatment of the subject makes it worth the effort.

IV. CASE HISTORIES OF THE EFFECTIVENESS OF PERFORMANCE BASED TRAINING SYSTEMS

Individualized Instruction Speeds Machine Tool Operator Training at Lockheed-Georgia, Training and Development Journal, Vol. 28, No. 12, December 1974.

This is a short but very important article which describes a typical performance oriented, individualized training program for technical level employees, in this case, machine tool operators.

The techniques used here are applicable to apprentice training or any level of technical training. Training time was reduced by more than 50%. The article also describes both the changes that came about in the role of instructors, and the ways in which this type of training helps to improve the motivation of trainees.

Altogether, an eye-opening article and one which clearly demonstrates the effectiveness of performance based instruction.

Wong, Wilson, Evaluation to Improve a Training System, Technical Education Reporter, Sept./Oct. 1974, p. 98.

A very important article! The IBM Office Products Division has abandoned the conventional classroom and adopted Self-Pace -- an individualized programmed instructional system to train people who service typewriters and office dictating equipment.

The article describes in detail the way the system works, the problems that had to be solved while installing it and the major advantages of the new system.

An Air Force evaluation team that audited the IBM system found that:

* Trainee time was reduced from 17 weeks to 11 weeks.
* Graduates performed better than did those who graduated from the old classroom program.
* Program was more flexible -- trainees could start when they needed to without waiting for a new class to start.
* Training costs were reduced by 15%.

* Performance tests used as part of the training system were reliable predictors of later on-the-job performance.

* Trainees liked the new system better than the conventional classroom training method.

This is a most effective article, not only in its description of the new IBM system but in its emphasis on measuring results and evaluation which are built into the system.

Hull, Daniel M., Adaptability Through Modular Instructional Materials, Technical Education Reporter, Sept./Oct. 1974, p. 37.

This article describes a system of modular training materials used to train a diversity of personnel in 155 well-defined tasks in laser technology. The validity of the modules was established through actual field measurement of their effectiveness. In the words of the author, "The success of the modules has been due to their validity and flexibility, characteristics that have made them adaptable to a number of learning environments."

This article too, points up the effectiveness and desirability of including measurement as an integral part of any training system.

Ronzheimer, K., We Increased Instructional Efficiency with Self-Instruction, Industrial Education, March 1973.

This article describes in detail how Waubonsee Community College has converted its auto mechanics curriculum to a self-paced program using the new educational technology.

The result has been a 50% increase in student achievement and more than a 100% increase in the number of students that can be handled with the same facilities and resources.

This approach is also being used in their machine shop curriculum.

They Roll Their Own Individualized Instruction, Training in Business and Industry, July, 1973, p. 36.

Another description of a program very similar to that of Wanbonsee College described above -- this one at Central Piedmont Community College in the city of Charlotte, N. C. The techniques used, the philosophy and the results are similar to those at Waubonsee.

Hughes, John L., ed., "Programmed Learning: A Critical Evaluation", Educational Methods, Inc., Chicago, 1963.

A book for the informed layman in industrial training who wants information on the effectiveness of programmed instruction.

The book describes what are now classic applications of P. I. in IBM, Eastman Kodak Co., Bell Telephone Labs, E. I. DuPont and General Telephone of California.

Das, Beman, "Applying Programmed Learning Concepts to Instruction in Performance Rating", Journal of Industrial Engineering, American Institute of Industrial Engineers, New York, March-April, 1965.

The purpose of this investigation was to see if the programmed learning method could be used successfully for instructing in industrial performance rating. The conventional method was a lecture in conjunction with the Society for Advancement of Management "Rating of Time Study Films"; the procedure was to show the films and then give the trainees feedback on how well they performed on the assignments they were given.

The programmed method used the same films, but in this manner. The films were cut and spliced so that first the trainees were shown the method of operation so that they would be familiar with the operation in question. Then, they were shown films of the same operation performed at five different levels of competence. Finally, feedback and remedial instruction were given to the trainees, and this same procedure was followed for each of the five operations in which the trainees were instructed.

It was thought that if the trainees could see an operation performed at different levels of competence, they would be able to differentiate more accurately among performance levels throughout the rating scale. Das concludes that trainees "trained by the programmed learning method rated more consistently and accurately than (those) trained by the conventional method after one hour of training".

Mager, Robert F. and Cecil Clark, "Explorations in Student Controlled Instruction", Psychological Reports, Southern University Press, Missoula, Montana, 1963, 13, pp. 71 - 6.

Mager and Clark report on three studies performed with trainees who began their training periods with varying amounts of relevant prior knowledge. Mager and Clark found that, when given control of their own curriculum (i.e., designing their own training), these trainees were better able to achieve the instructional goals which management had prescribed to them.

One study involved a six-month engineering course given to engineering graduates with no prior experience in a manufacturing division of Varian Associates. The standard course involved six weeks of formal lectures, six weeks of rotation through the various departments and a three-month assignment as an assistant to an experienced engineer. The standard course was replaced by a training system which provided the trainees with a list of specific, detailed objectives that they were supposed to achieve, and then allowed the trainees to arrange their own way of achieving them. They were allowed to request instruction from anyone in the division; the only requirement was that they achieve the objectives completely. The results:

* Training time was reduced 65%. All students were permanently assigned six to eight weeks after training began, rather than after the old program's six months.
* Graduates of this program appeared to be better equipped, were considered by the division manager to have been better trained, than graduates of the old program.
* Considerably less time was needed for training by instructors, administrators, and technical experts.
* Content selected for study varied from student to student, as did the sequence of the content chosen.

Talley, M. Robert, "An Overview of Training Techniques at the Travelers Insurance Companies", Educational Technology, September, 1969, Training Technology Supplement, page S20.

Travelers went from losses with the "Buddy" system of on-the-job training to success and reduced losses with instructional technology. They now use a combination of programmed instruction and multi-media presentations for their people. The development of their program, described in the article, began with a job analysis to define what should be taught to new and career employees who handled policies and claims.

Results: training time was reduced, error rate was reduced, implementation of new product lines became easier and more efficient, employees were better equipped to handle complexities on the job, and turnover was somewhat reduced.

Hughes, J. L. and W. J. McNamara, "A Comparative Study of Programmed and Conventional Instruction in Industry", Journal of Applied Psychology, August, 1961, p. 225.

This article describes a program which replaced the introductory section (originally 15 hours of conventional classroom presentation) of a 16-week course on the IBM Data Processing System given to computer service men at a company training center. The program (five textbooks containing 719 frames) was carefully developed, administered, and tested. Results were impressive -- 35% reduction in actual training time and a 9% increase in quality of performance.

Of particular interest would be the unusually comprehensive testing procedure and handling of statistical results; also the discussion of trainee comments: 87% of the trainees liked the self-paced instruction better than conventional classroom instruction.

Mager, Robert F., "On the Other Hand", Improving Human Performance: A Research Quarterly, NSPI, Washington, D. C., 1973, 2, 77 - 88.

Seven very brief case studies are used to illustrate the present advanced stage of development of instructional technology. Although the author is concerned with both industrial training and education as it takes place in schools, his concern for measured results in both arenas is both timely and greatly needed.

The industrial case problems give good evidence of the effectiveness of instructional technology in the industrial setting.

Sullivan, D.J., et. al., A Survey of the Present State-of-the-Art in Learning Center Operations, AFHRL-TR-74-11, February 1974, Hq. Air Force Human Relations Laboratory (AFSC), Brooks AFB, Texas

V. PROGRAM DEVELOPMENT

Mager, Robert F. and Kenneth M. Beach, Jr., Developing Vocational Instruction, Fearon Publishers, Belmont, California.

Another straightforward down-to-earth Mager book. This one follows logically from Analyzing Performance Problems, Goal Analysis, and Preparing Instructional Objectives -- it goes from the prepared and analyzed point and shows how to design and write appropriate training programs. The approach is logical step-by-step, and each step is explained and illustrated with examples.

Dolmatch, Theodore B., Elizabeth Marting and Robert E. Finley (eds.) Revolution in Training: Programed Instruction in Industry, American Management Association, New York, 1962.

This is a collection of articles on the experiences of various companies in the use of programmed instruction for employee, and in one case, customer, training. Trainee occupations and levels are many, and the companies represented include General Telephone Company of California, Lever Brothers, IBM, Sandia Corporation, Mead Johnson, and Zenith, to name a few.

In addition to supplying reports on specific company experiences with programmed instruction, the book provides in the section "Focus on Industry" four articles on the history, nature, state of the art, and application of programmed instruction to business and industry's training needs.

Berger, Mike, "The Microprogram", Training in Business and Industry, May, 1974, p. 34.

This is a short article which proposes the idea of and suggests a methodology for using short programmed instruction courses for one-idea or one-technique training -- for example, how to fill out a medical claim form. Applications mentioned in the article include operating techniques, forms completion and processing, and portions of new-hire orientation.

One case of microprogram success is cited: the installation of a new weekly indemnity insurance program at the 1000-man plant of Litton Industries Guidance and Control Systems in Salt Lake City, in which the traditional lecture approach resulted in a 55% signup rate and the microprogram in a 73% signup rate.

Harless, J.H., "A Technology of Performance Problem Solving", Educational Technology, July, 1970, p. 32.

An historical article, which treats the development of programmed instruction from its being a "product" or an esoteric toy of educators to being a technology of performance problem solving, a concrete, earthbound system of helping people to do their jobs better, to make their training more effective.

Margulies, Stuart and Lewis D. Eigen (eds.), Applied Programed Instruction, John Wiley and Sons, Inc., New York, 1962.

This is a collection of articles from many sources on experiences with programmed instruction in and for a wide variety of situations, subjects, purposes, and trainees. Sections of this book are as follows:

1. Introduction
2. Internal Industrial Programs
3. Military Programs
4. Computer-Based Teaching Systems
5. Market Analysis and Economic Considerations
6. Machines and Devices
7. Programmed Agencies

The appendices are also of interest, as they supply portions of sample questionnaires and programs.

Dolmatch, Theodore B., "Programed Instruction -- the Managerial Perspective", Personnel, January-February, 1962, p. 45.

A good basic overview of what programmed instruction is; how it fits into industry's needs, its advantages from the time-saving, money-saving, achievement-raising, individualizing of training, and scheduling aspects.

Lysaught, Jerome P., "Industrial Training Through Programmed Learning", Personnel Journal, September, 1961, p. 165.

The author, drawing from his experience at Eastman Kodak Company and Recordak Corporation, addressed the following questions:

* Why program?
* Is programmed learning effective, and if so, how effective?

* What are the advantages/disadvantages of programmed instruction in terms of time (development and trainee), cost, achievement level, administration?
* How and what do you program? Where do you find good programmers?
* What do the trainees think of it?
* What is the future for programmed instruction?

Pipe, Peter, Practical Programming, Holt, Rinehart and Winston, Inc., New York, 1966.

This is a quick (68 pages!), sensible, down-to-earth book which ever the intelligent beginner can use. Pipe begins with a discussion of what programming is, its history, and what is meant by linear and branching programs. He then proceeds into the methodology -- topic selection through writing the program, and finally testing and revision -- step-by-step, in logical order, using clear and concise terminology.

Markle, Susan M., Good Frames and Bad, John Wiley and Sons, Inc., New York, 1969.

This is probably the best and most complete book on designing, writing, testing, and editing programmed instruction available today. Presentation of information is logical, clear, and detailed; and the book provides its own example, in that it is, except for a couple of essay sections, programmed instruction itself. Chapters are as follows:

1. The Basic Programming Principles
2. The Basic Elements and Operations
3. Systematic Approaches to Design
4. Adaptive Programming and Individual Differences
5. Editing

There is also a most valuable Glossary at the end. This would be a good choice to follow a reading of Peter Pipe's Practical Programming.

Burns, Richard, Methods for Individualizing Instruction, Educational Technology, June, 1971.

Gilbert, T. F., "Mathetics: The Technology of Education", The Journal of Mathetics, January, 1962.

Knirk, F.G. and Castelle G. Gentry, Applied Instructional Systems, Educational Technology, June, 1971.

VI. COST EFFECTIVENESS

Temkin, S., Making sense of benefit-cost analysis and cost-effectiveness analysis, Improving Human Performance: A Research Quarterly, 1974, 3.

Considerations of economic efficiency permeate much of the current dialogue about public sector needs and remedies. Few organizations today can avoid constraints imposed by the amount of available dollars. Hard decisions in the face of shrinking dollars and seemingly ever expanding needs have ushered in a vocabulary of efficiency. This essay attempts to clarify some of the meanings and implications of the new vocabulary as it now impinges upon not only our everyday lives, but also upon the decisions we make and those which are made for us.

Roid, G.H., Issues in judging the cost-effectiveness of self-instructional programs: case study in programmed dental instruction, Improving Human Performance: A Research Quarterly, 1974, 3, 49-63.

A distinction is made between cost-effectiveness issues confronted by instructional developers and those confronted by users of developed instruction. Six issues in cost-effectiveness analysis are discussed with reference to decisions that need to be made by developers and users in higher education and professional education. A case study in programmed dental instruction is presented to provide examples. Some of the relevant literature is reviewed and referenced.

VII. PERFORMANCE TESTING

Boyd, Joseph L. and Benjamin Shimberg, Handbook of Performance Testing, Educational Testing Service, Princeton, N.J., 1971.

A complete and detailed handbook useful for anyone who wants to learn how to construct and use job performance tests. The book contains a large number of examples of actual performance tests from a wide variety of jobs.

Schmidt, Frank L., et. al., A Performance Measurement Feasibility Study, A Research Report prepared for the Manpower Administration, U.S. Department of Labor, September, 1974.

A useful and informative research report on a field test of a number of experimental performance tests on set-up and operation of lathes, mills, drills, and grinders.

The study demonstrated that minority/majority group differences are substantially smaller on performance tests than on paper and pencil aptitude tests.

Osborn, William C., "Framework for Performance Testing", Training in Business and Industry, May, 1974, p. 28.

A straightforward guide to developing performance testing -- how well is the man/woman doing the job. It uses a flowchart approach, with each step clearly explained. Besides straight methodology of testing, there is consideration given to questions of how reliable the test is, "why the trainees scored the way they did", and how one can cope with limitations of time, space, and procedures.

The article is of particular interest, also, as it ties in so strongly with the problem analysis and instruction planning which must be done for any training project -- testing is part of the project, and not an afterthought.

Morrison, Edward J., "Pass or Fail: How to Test Performance", American Vocational Journal, April, 1973, p. 38.

A quick how-to article on testing, this covers what is the proper kind of test for a given situation, setting standards, making observations, recording results, and scoring. It includes testing on performance on machines, as well as other kinds of skills and knowledge performances. Particular emphasis is placed on effective testing combined with a theme of total fairness to the trainee and common sense.

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